DECEMBER 1955

Power Engineering

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Fig. 1138 (left) non-rising stem, Fig. 1140 (right) OS&Y... two of 29 OIC iron valves with steel valve features. Metals used for trim and pressure parts in this line include: bronze, manganese bronze, nickel-plated steel, higher strength iron, nickel-alloyed iron, Monel, 18-8 stainless, 11-½-13 chrome.

Reduce valve wear. Choose from 29 OIC iron valve numbers with 9 different trim and body metal variations. Depend on them for general use and process industry services handling alkaline liquors, creosote, sour crude, sulphuric acid and caustics.

Working parts design assures positive seating . . . long life

Seat rings are end seated, reducing the probability of loosening in service and affording streamlined flow from port to port. Body wedge guides and a flexible T-head stem-wedge connection combine to assure accurate wedge seating for tight shutoff.

Extra strength adds safety to pressure parts

High-strength iron castings assure pressure parts made to a minimum tensile strength of 31,000 psi. The body and bonnet, elliptical in shape, resist internal pressure with least possible distortion. Body-bonnet bolting provides uniform gasket loading and, consequently, a pressure-tight seal throughout the pressure range of the valves. Tie ribs, cast between the pipeline flange and the body bonnet flange, prevent distortion from excessive pipeline stresses.

This line's many added features, trim variations, dimensions and end openings are completely described in the new OIC specification folder, Form No. 1005. Write for it.

Order valves from your OIC Distributor.

OIC
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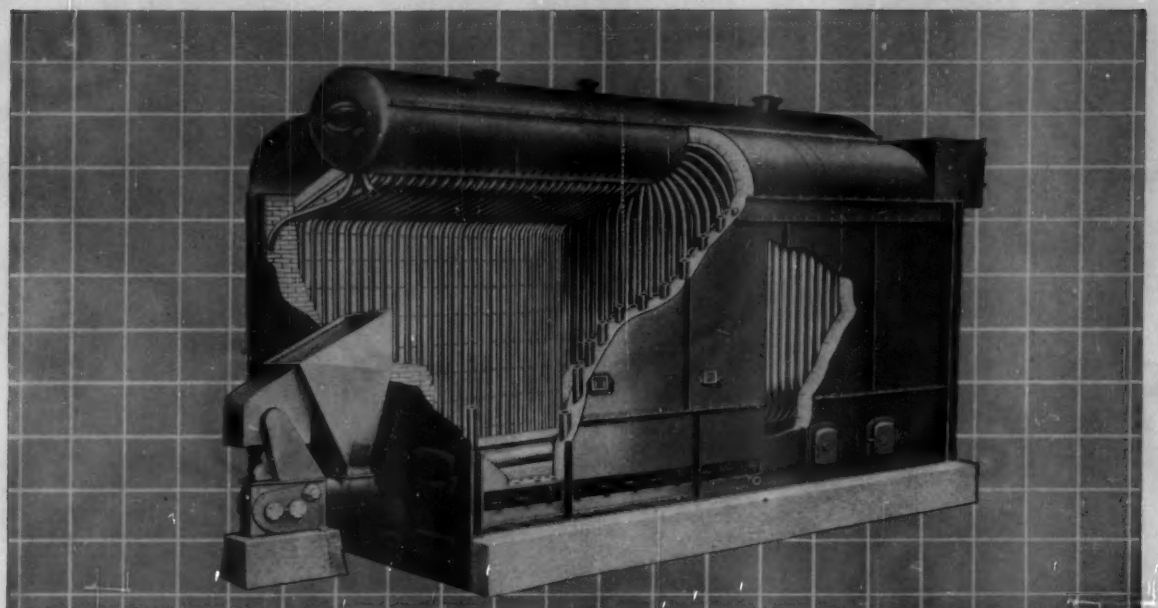
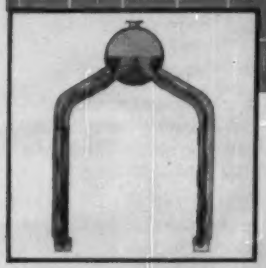
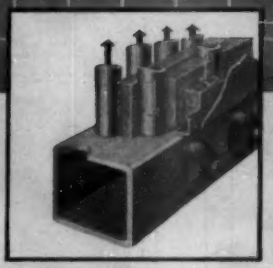


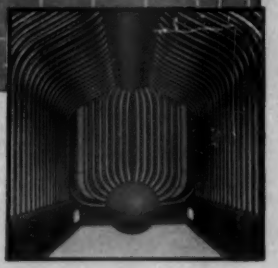


RING-FLOW CIRCULATION IN EACH WATER WALL ELEMENT

POSITIVE WATER SUPPLY TO WATER WALLS



WATER WALLS ACCESSIBLE FROM OUTSIDE THE SETTING



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The VI factory assembled or field erected, has EXCLUSIVE features that assure minimum furnace maintenance and a positive supply of clean water to the water walls. These EXCLUSIVE features are the result of many years of experience in designing and building two drum boilers; thousands of which are operating in the field today, giving users the satisfactory service they demand.

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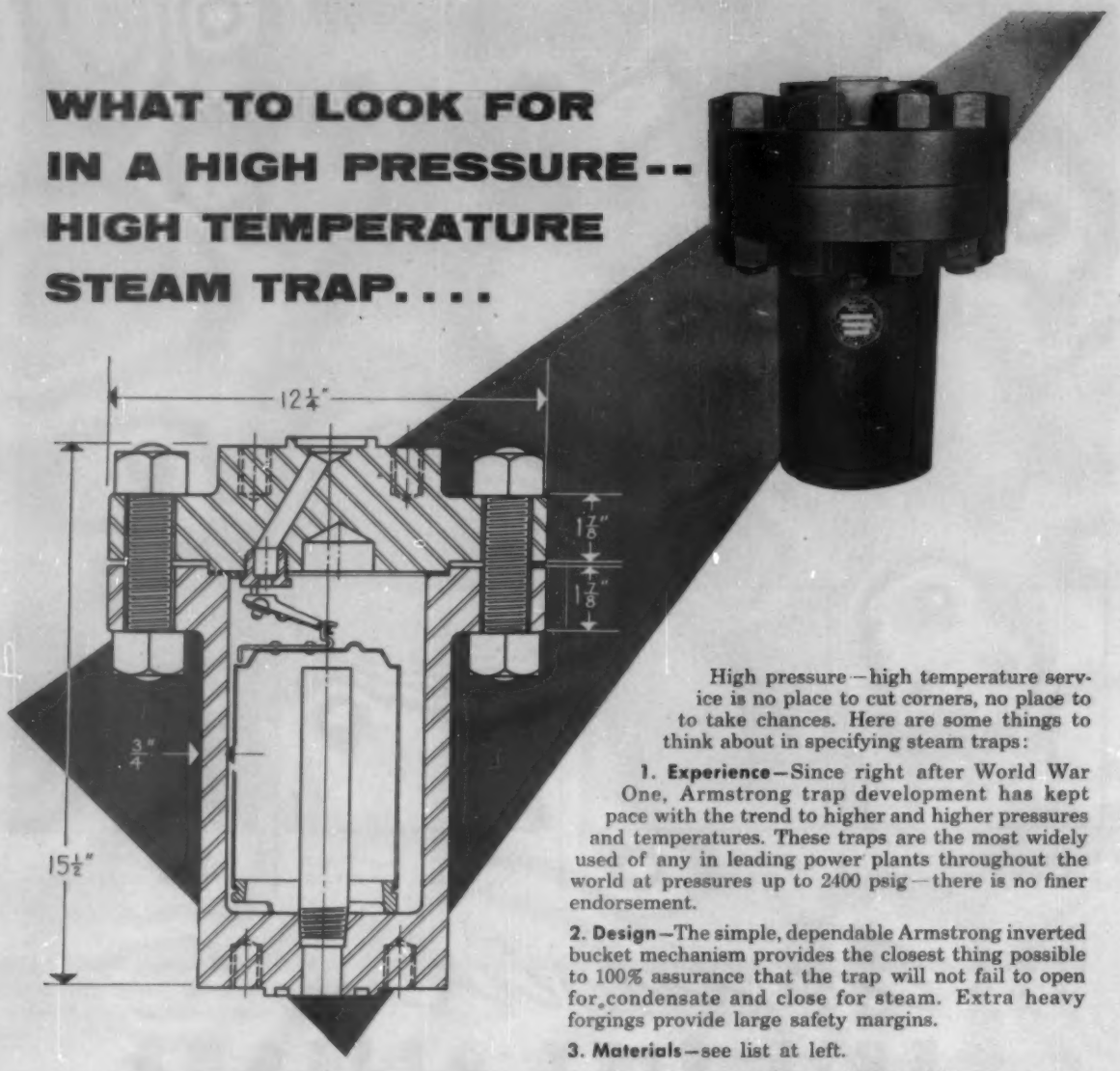
WHAT TO LOOK FOR IN A HIGH PRESSURE-- HIGH TEMPERATURE STEAM TRAP....



High pressure—high temperature service is no place to cut corners, no place to to take chances. Here are some things to think about in specifying steam traps:

1. Experience—Since right after World War One, Armstrong trap development has kept pace with the trend to higher and higher pressures and temperatures. These traps are the most widely used of any in leading power plants throughout the world at pressures up to 2400 psig—there is no finer endorsement.

2. Design—The simple, dependable Armstrong inverted bucket mechanism provides the closest thing possible to 100% assurance that the trap will not fail to open for condensate and close for steam. Extra heavy forgings provide large safety margins.

3. Materials—see list at left.

4. Price—Armstrong forged steel trap list prices range from $95 to over $1000. The No. 515 shown above is rated for 1500 psig at 900°F and for 2000 psig at 600°F. It lists at $500. Armstrong prices are moderate for what you get because of high production. *There is no compromise made at the expense of safety, quality and low maintenance.*

Want more facts?—Call your local Armstrong Representative or write: Armstrong Machine Works, 810 Maple Street, Three Rivers, Michigan.

Do you have Catalog J?—This 44-page Steam Trap Book is free on request.

LIST OF MATERIALS
ARMSTRONG FORGED STEEL TRAPS

Part	Material
CAP AND BODY FORGINGS	
Up to 600 psi, 750°	1030 carbon steel
Up to 900 psi, 900°	ASTM Spec. F-1 carbon moly steel
Up to 2500 psi, above 900°	ASTM Spec. F-5 chrome moly steel
VALVE AND SEAT	Type 440 chrome steel, heat treated, standard. Stellite available.
LEVER MECHANISM	Stainless steel
BUCKET	Stainless steel
BOLTS	Class C high tensile, high temperature bolting material—125,000 min. tensile.
NUTS	Hex, semi-finish, heat treated for high pressure, high temperature service.
GASKET	Compressed graphited asbestos
INLET TUBE	Wrought iron

STEAM TRAPS FOR EVERY REQUIREMENT — APPLICATION ENGINEERED

ARMSTRONG STEAM TRAPS

For more data circle 503 on Post Card

ENGINEERS' PREVIEW

INTERESTING 40-page booklet entitled "Women in Engineering" has recently been published. Among other things it consists of a series of articles mostly by well-known women engineers. It discusses: what is engineering; our untapped source of engineering talent; educating women for engineering; petticoats and slide rules; engineering as a career for women; engineering scholarships for women; gives data on college courses leading to first degrees in engineering, and some facts about the Society of Women Engineers. The booklet contains a foreword by Lois G. McDowell, at that time chairman of the Professional Guidance and Education Committee of the Society, and recently elected president of the Society for 1955–1956, as noted in the August 1955 issue of POWER ENGINEERING. Mrs. McDowell is assistant professor of mechanical engineering at the Illinois Institute of Technology.

For more information about this booklet, write the Society of Women Engineers, 4 Washington Square N., New York 3, N. Y.

• • •

PREPARED under supervision of American Gas and Electric Service Corporation by and for associated operating companies, the AGE Plant Safety Manual has recently been issued.

The manual, in a handy 5 by 7½ in. size with stiff cover and back, is divided into seven sections, for each of which rules and instructions for safe working are listed. The sections are: General, listing the basic rules for safe work in any situation; Power Plant, Transportation, Office, First-Aid, Resuscitation, and Data. Data includes such information as crane signals, knots and hitches, load stresses in blocks, tackle, slings, planks and beams. An index is provided and also cross-references between sections.

• • •

AN EDITOR FRIEND, who conducts a manufacturer's house magazine in a relatively non-technical field, recently showed us a letter from one of his readers in which there was a reference to "turban oil." Naturally, we got a good many chuckles out of this, but it remained for Tom Hanson, genial editor of our companion magazine *Plant Engineering*, to point out that this probably referred to the lubricants required for the headgear of whirling dervishes.

• • •

NAVY TECHNICAL NEWS, formerly published by the Office of the Chief of Information, Department of the Navy, is now being published privately by Hugh Swofford & Associates, Inc. Subscription is $3 per year and sample copies are available on request from Hugh Swofford & Associates, Inc., 270 Park Ave., New York 17, N. Y.

• • •

PROPOSED STANDARD on letter symbols for feedback control systems is now in course of preparation. As administrative sponsor for Sectional Committee Y10 on the Standardization of Letter Symbols, The American Society of Mechanical Engineers is making available a copy of Tentative Standards subject to revision, and distributing this proposal for criticism and comment. All engineers interested may obtain copies of the tentative draft free of charge by addressing Frank Philippbar, Standards Department, The American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.

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NBP EEA

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POWER ENGINEERING
Yearly Index

Index of POWER ENGINEERING'S 1955 articles will be included in the January 1956 issue instead of the December 1955 issue, as we have done in December issues for years.

This slight change, necessitated by certain mechanical make-up problems, will enable us to improve the index to serve you better.

Watch for it in January and let us know what you think of the change.

ONE OF the country's — and the world's — authorities on conversion of energy by power plants, Harry A. Kuljian, took a searching look at the World's Energy Resources in POWER ENGINEERING, March 1954 issue, page 96. Mr. Kuljian has reprinted that article in an attractive booklet; copies of it are now available from The Kuljian Corp., 1200 N. Broad St., Philadelphia 21, Pa.

• • •

NATURAL GAS has become the fastest growing primary fuel in North America, according to a recent report from H. C. Barten, Manager of Worthington Corp.'s Gas Transmission Section of Engine Sales Division. A recent survey conducted for his company showed that consumption of natural gas has increased from 500,000,000,000 cu ft in 1920, to more than 6,000,000,000,000 in 1950.

Today, well over 20,000,000 people in the United States rely solely upon natural gas for heating and cooking purposes. In addition, upwards of 2,000,000 industrial firms are using gas as a major source of energy in their manufacturing operations.

• • •

CONTRACT for a 74,500-hp, 240-rpm, 1151-ft head, six-jet vertical impulse type hydraulic turbine, one of the largest of its kind in physical size and capacity in the United States, has been awarded by Tri-Dam Constructors, contractors for the Oakdale and South San Joaquin Irrigation Districts in California, to Allis-Chalmers Manufacturing Co. Oakdale and South San Joaquin Irrigation Districts will be joint owners of the Donnells and Beardsley projects being developed on the Middle Fork Stanislaus River.

The 74,500-hp unit will be installed in the Donnells plant while the Beardsley project will be provided with a 14,000-hp, 258-ft head, 300-rpm Francis runner, field-riveted spiral-casing type Allis-Chalmers hydraulic turbine, complete with cabinet governor, pressure regulator and 78-inch butterfly valve.

LETTERS TO THE EDITORS

Interesting Notes: Humphrey Internal Combustion Pump

To the Editor:

I WAS INTERESTED in the article contained in your September 1955 issue, entitled What Happened to the Humphrey Internal Combustion Pump?

My interest arises from the fact that I was one of the first members (1910–13) of the engineering staff of what was then the Pump and Power Company and was subsequently renamed the Humphrey Pump Company. Also, I did most of the calculations on the Chingford pumps and on other installations, some of which were actual and others were merely projects. They included both the four and two-stroke types.

These pumps had the advantages of simplicity in principle and absence of moving parts, save in the valve gear. They were, however, very large for their output and required considerable civil engineering work. For instance, the Chingford pumps had cylinders seven feet in diameter and had about forty 5-inch valves in the cylinder head, which were controlled by an automatic inter-locking gear.

Further, in view of the fact that the suction valves opened when the water column was moving at its maximum velocity, a very large suction valve area had to be provided. Also, the shocks at the bends were quite severe and required the use of heavy castings. At the time, when the Chingford pumps were constructed, the steel castings required were too large and heavy for the Sheffield steel industry and consequently they had to be made by Skodawerke, Pilsen.

I know this, because they were inspected by the Bureau Veritas and I checked the drawings personally. Further, the simple pumps shown on page 85 of your September issue were very sensitive to changes of head, because the "cushion" stroke which compressed the products of combustion, produced a pressure in the cylinder that was higher than the combustion pressure. It is obvious that, with a cylinder seven feet in diameter, the possible aggregate pressure was very large and, therefore, the cushion pressure was a limiting factor. If the volume of the clearance space was increased to keep down the cushion pressure, the entering charge was diluted excessively by the products of combustion remaining from the previous cycle and the output was reduced correspondingly.

Shortly before World War I, we quoted and obtained an order for a number of large pumps for irrigation purposes in Egypt. These were designed to pump 80,000 gallons of water per minute to a head of 20 feet.

This would have given very favorable conditions for stable operation of the Humphrey pump, but construction was interrupted by the outbreak of World War I, and, as far as I know, it was never resumed. The pumps in question were about eight feet in diameter.

I have a vague recollection that a small two-cycle pump was tried out on an experimental basis and several schemes were projected for two-cycle pumps to be used for low head work (drainage) in Holland. The reason for this was, that the velocity of the water column and consequently the number of cycles per minute depended on the head and, under these circumstances, in spite of its other limitations, the two-cycle pump was likely to be more suitable than was the four-cycle type.

We also projected the use of a solid metallic piston in place of the water column. This had some disadvantages and I am not sure whether any units were made, but I am reasonably sure that patents were taken out, because I prepared the patent drawings. It is possible that the use of solid reciprocating masses in internal combustion engines, which is now receiving considerable attention, had its origin in these projects. — *E. A. Allcut, Professor and Head of the Department of Mechanical Engineering, University of Toronto, Canada*

higher loads...
economy fuels...
new
engine designs...

there's one answer for all three of these lubrication problems—

Demands upon the lubricant in stationary industrial engines are increasing. More severe operating conditions caused by heavier loads, new engine designs and the use of economy fuels pose difficult lubrication problems not met by conventional oils. Standard Oil Company introduces a lubricant specifically designed to meet these problems—STANODIESEL Oil M.

STANODIESEL OIL M

STANODIESEL Oil M meets or exceeds the requirements of a lubricant for stationary industrial engines. Here's why:

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Special additives are blended with this STANODIESEL Oil M base stock. An oxidation inhibitor prevents unwanted increases in oil viscosity and prevents corrosion of bearings. The action of detergent-dispersant additives keeps crankcase, pistons, cylinder walls and other parts clean. Contaminants are kept in suspension and are prevented from depositing. An anti-foam agent makes this oil suitable for use in hydraulic governors. A wetting agent increases the oil's ability to reach and maintain a film on such highly stressed parts as cams and cam followers.

Use of STANODIESEL Oil M means this: less engine deposits, less ring and cylinder wear. Less spark plug fouling when used in gas engines. Eliminates fuel injector and pump sticking caused by deposits on the injector barrel and plunger when fuel and lubricating oil commingle.

You need to know about STANODIESEL Oil M. In the Midwest, call your nearby Standard Oil lubrication specialist. You will receive the information promptly. Or write Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD

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HERE'S WHAT THEY TELL US

IN ANSWER to a reader's letter concerning power production of tomorrow in this country, Editor Kramer said the West Milton atomic plant of the General Electric Company sells atomic power to the Central Hudson System at a rate of three mills per kilowatt hour. And the efficiency of the solar power system of the Bell Telephone Company, which they are trying out in Georgia, even now is about equal to what we do in some of our good steam plants. He added

> There may be a great future in this type of solar generator. Of course, if we ever do lick the thermonuclear power problem, I don't think that we will have to worry about solar power because, if we can effect the fusion of hydrogen or lithium, our power problems will be over for all time.

WE WERE PLEASED to give Harrison Engineering Services permission to quote all or part of the article, Vibration Tolerance by T. C. Rathbone, from the November 1939 issue of *Power Plant Engineering* (former title of the present POWER ENGINEERING). R. E. W. Harrison wrote

> As a result of correspondence with T. C. Rathbone, I am advised that it is agreeable to him for me to quote all or part of his article as a part of a paper which I expect to have published in the Journal of the American Society of Naval Engineers.
>
> As I expect that *Power Plant Engineering* holds the copyright on this article, I wonder if you would be good enough to give me the permission of your organization to quote all or part of Mr. Rathbone's paper in my forthcoming article?
>
> For many years, as an Engineer Captain in the U. S. Navy, I was responsible for machinery elements which generate vibration to a degree which is dangerous to the ship. My contemplated article for the Naval Engineer Journal deals with this subject, and is aimed at stimulating the interest of the current generation of naval engineers in this age-old problem.

T. E. KASS, Westvaco Mineral Products Division, Food Machinery and Chemical Corp., commented

> We have been interested in your article on ferrophosphorus aggregate as contained in the October 1955 issue of POWER ENGINEERING and are planning to carry out some experimental work with this material. We would, therefore, appreciate receiving a copy of the data sheet entitled Dense Concrete, at your earliest convenience.

The data sheet was quickly sent on its way to Pocatello, Idaho.

WE ARE ALWAYS complimented by the fact that our readers expect us to know about every detail of things used around a power or industrial plant. Roy Loding of Michigan recently queried

> Formerly with Fruit Belt Electric at Cassopolis, I am now with Wolverine Electric Coop at Hersey. We used to buy Blue Ribbon Metal polish from National Mill Supply but I can't find any up here. Can you tell me who makes the polish, or where we can get some?

The polish is now supplied by International Metals Polish Company, Quill Street and Belt R. R., Indianapolis, Ind.

CHIEF ENGINEER Earl R. Myntti, Bent & Bros., Inc., who requested a change in mailing, noted

> . . . thought that I would also take the time to tell you that I think POWER ENGINEERING is a very fine magazine which I find very useful.

BERNARD J. RANDALL, Synco Corporation, said:

> I wish to congratulate you and your staff for the fine issue of POWER ENGINEERING which I have just read. Its clarity, brevity, and style coupled with the facts which it presents makes POWER ENGINEERING an outstanding example of good journalism.

KYANG-JIN LEE, in a letter to our editor, said

> I am glad to have the opportunity of writing to you. In the first place, I have to introduce myself to you.
>
> I came from Seoul, Korea, to study power plant engineering four months ago. I finished the engineering classes at the University of California by special program. Now I am taking an on-the-job training course at a steam power plant located in San Francisco. I graduated from the Engineering College National Seoul University. After I get back to Korea I will be a watch engineer for our new power plant.
>
> When I worked at the Pacific Gas and Electric Co. plant in San Francisco, I had a chance to see your magazine POWER ENGINEERING. If it's available to take monthly, I will take it every month from now. I will take this magazine not only during my stay in the United States but also after I get back to our country.

R. B. SCAMMON, The Travelers, Conn., wrote

> I have noted in your July issue of POWER ENGINEERING that the article, "So — You're Going to Overhaul Your Turbine Generator," is later to be reprinted in full after the whole series has gone into publication. As these articles appear mostly in the form of pictures with only short descriptive notation as to what is being accomplished, I believe they would be very useful in assisting in training our young engineers in the field who have not had full training in the construction and overhauling of a turbine generator.
>
> It is mentioned in the article we should write to you to reserve a copy of this reprint when it is completed. I am wondering if it might be possible to purchase about 250 copies of the reprint, and how much the charge would be for this number of copies?

We think probably the cost will not exceed $1 per copy for this 48-page reprint, and we hope much less.

AFTER SOME 50 YEARS in the utility business, 14 with Commonwealth Edison Co., Chicago (his last job as "Buck" Grunert's assistant) then 36 years with the Kansas City Power & Light Co. as Results Engineer in the Production Department, E. L. McDonald has called it a day. He hopes ultimately to retire in Florida.

In past years he has been active in ASME affairs, past chairman of the Kansas City section, a present member of Power Test Code No. 4, and chairman of the subcommittee that put the "heat loss" method of boiler testing in acceptable form for publication. He is author of many papers on this and other engineering subjects. With atomic power plants ahead, perhaps it is well, says Mr. McDonald, that some of us pass out of the picture, because we would have to start all over again.

One of his pleasantest memories, he says, is that of being a member of the Prime Movers Committee (publishing the first high-pressure high-temperature report) during the years when such notables as Bailey, Grunert, Ricketts, Moultrop, Anderson, Tenney and others were doing their outstanding and important work.

This NEW Handbook
of engineering data on J-M products

. . . provides valuable information to help you solve many design and operating problems

Here is a new handbook which can be a valuable aid to you in many ways in improving operations and lowering maintenance costs in your plant.

Whether your problem is reducing heat loss, fighting corrosion, sealing gases and liquids, controlling motion, filtering liquids, improving formulae or protecting against fire, weather and wear, this handbook will aid you in finding the solution.

This handbook contains 52 pages of useful up-to-date engineering information on Johns-Manville products used in the process industries. The answers to your thermal insulation problems may be found in the section which shows methods of calculating heat transmission. Also included are tables of heat losses from bare surfaces and equivalent thicknesses of pipe insulation. Graphs provide information on surface resistance for both pipes and flat surfaces.

For your copy of this handbook, simply fill out the attached coupon and return it to us.

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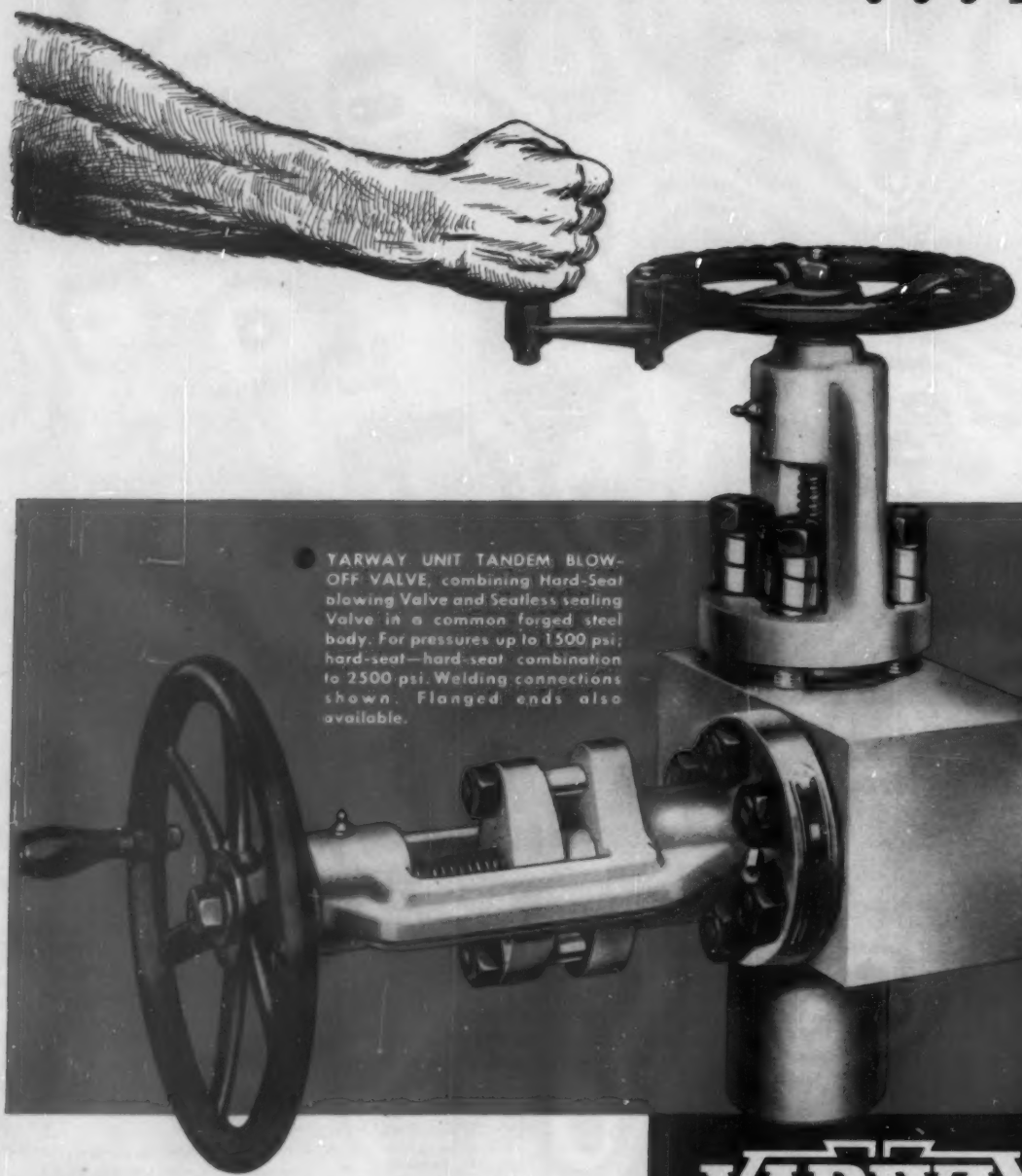

YARWAY UNIT TANDEM BLOW-OFF VALVE, combining Hard-Seat blowing Valve and Seatless sealing Valve in a common forged steel body. For pressures up to 1500 psi; hard-seat—hard-seat combination to 2500 psi. Welding connections shown. Flanged ends also available.

YARWAY

rugged blow-down service

YARWAY UNIT TANDEM BLOW-OFF VALVES

When boiler pressures are high you may not "blow-down" very often, but, man, when you do, you're glad those blow-off valves are rugged YARWAY Unit Tandems!

More than 80% of high pressure boiler plants are equipped with YARWAY *Blow-Off Valves,* and there's ample reason.

YARWAYS are strong, heavy-duty valves giving the important extra dependability needed for the severe combination of high pressures (hence high velocities), acid cleaning, and abrasion caused by precipitated solids.

YARWAY Blow-Off Valves also are relied upon to keep boiler level within desirable limits during quick starts of high pressure boilers.

Specify YARWAYS—to protect *your* boilers. Write for Bulletin B-434.

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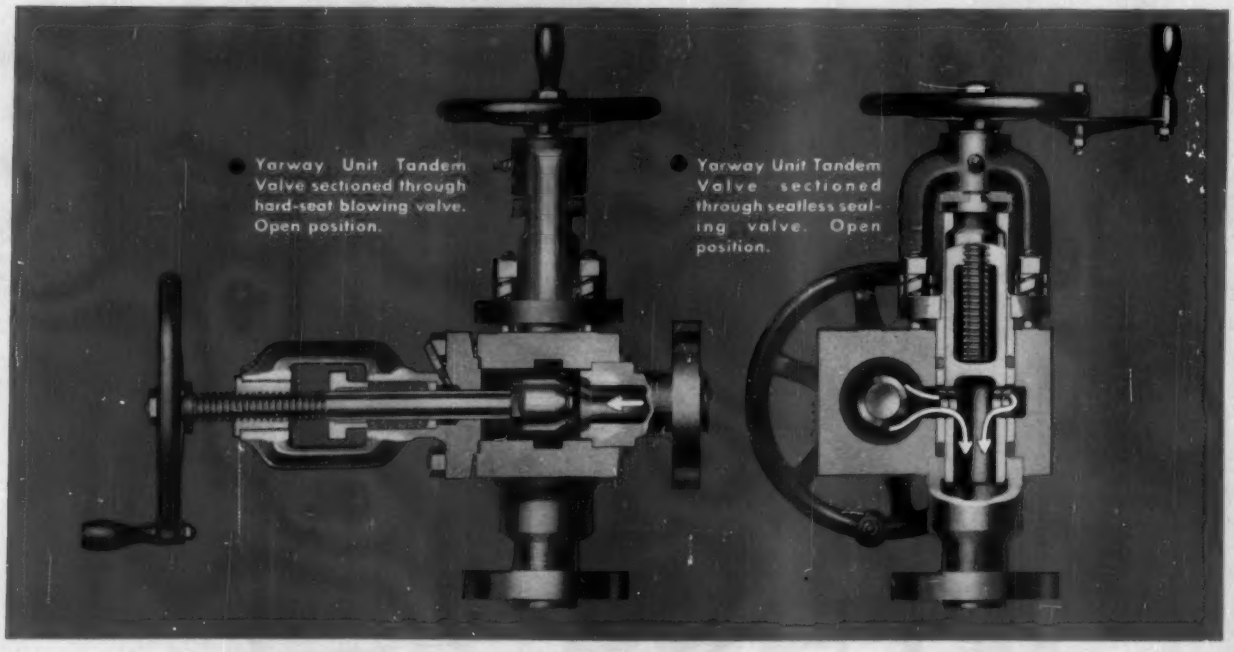
BRANCH OFFICES IN PRINCIPAL CITIES


Yarway Unit Tandem Valve sectioned through hard-seat blowing valve. Open position.
Yarway Unit Tandem Valve sectioned through seatless sealing valve. Open position.

— blow-off valves

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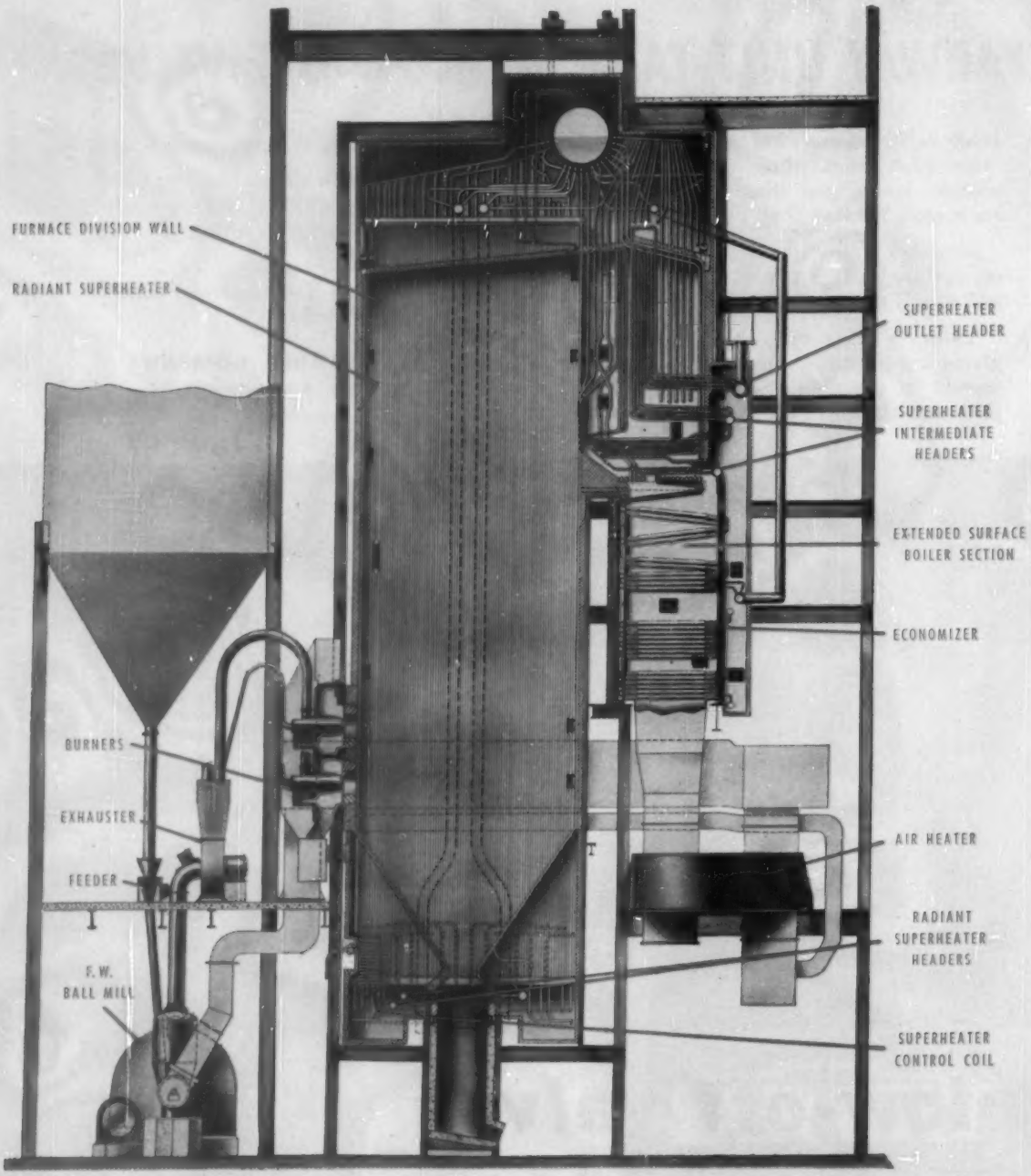
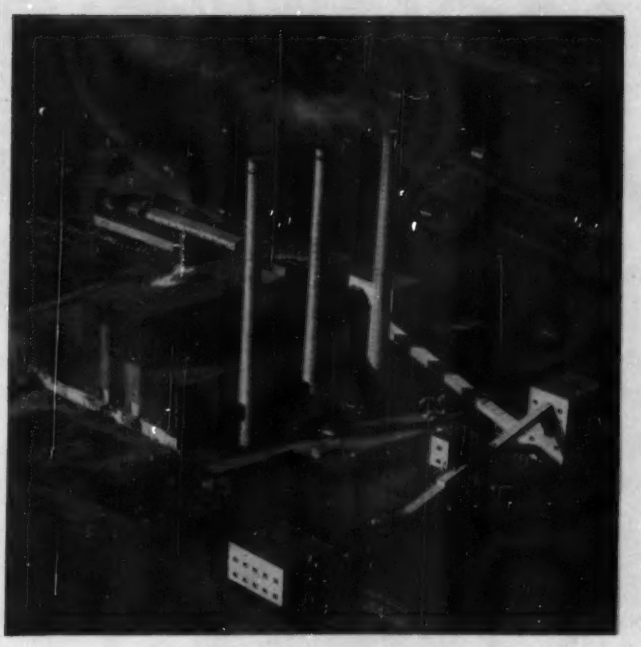
large mid-western utility

8th — FW STEAM



installs

GENERATOR



New Foster Wheeler Unit supplies 860,000 lb/hr at 1700 psig for 100,000-kw turbo-generator ... brings total capacity on this one system to 2,145,000 pounds per hour!

Latest addition to the modern steam plant shown above is a new 100,000 kw turbo generating unit. It is served by the Foster Wheeler unit shown in section at the left, which generates 860,000 pounds of steam per hour, at 1700 psig pressure and a temperature of 1000 F.

This installation marks the *eighth* large Foster Wheeler steam generator now "on line" in the various stations of this *one* utility system. Among the features of this unit are the FW combination radiant and convection superheaters, new horizontal steam separators, the reliable FW ball mill pulverizer system and the improved inter-vane burners.

Here we have positive proof of customer satisfaction — based on years of actual on-the-job performance with previously installed FW equipment. That means satisfaction that covers every phase of the job, from planning and erection to successful operation and servicing.

Repeat orders like this, from leading utilities throughout the country, are your best assurance of trouble-free steam generator performance. Whatever your pressure, capacity or steam purity requirements, you can meet them *with confidence* by specifying Foster Wheeler equipment. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

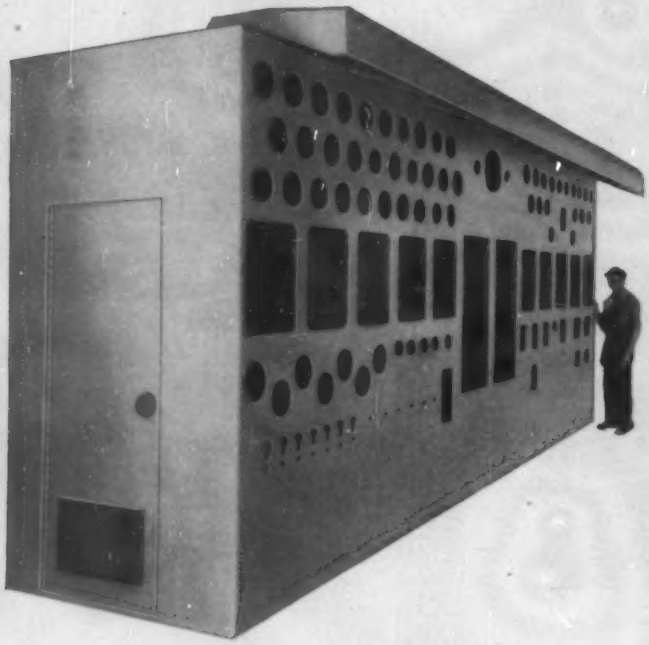
FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

For more data circle 507 on Post Card

Control Enclosures and Panels

fabricated by KIRK and BLUM



Whatever your requirements in control panels or electrical enclosures, KIRK & BLUM is equipped to fabricate them to your most exacting specifications. Whether it's a board with one or two instruments . . . or almost a hundred (as illustrated above) KIRK & BLUM has the experience and facilities to do a first-class job.

The control panels above, constructed for an electrical machinery manufacturer, are 20′ and 28′ long, 8′–6″ high and 4′–8″ deep. The body of the panel is constructed of ¼″ steel plate, the light canopy above of ⅛″ steel.

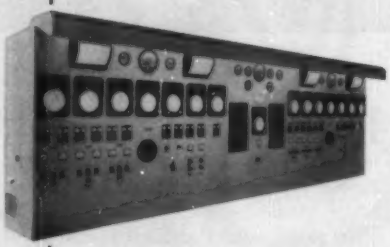
KIRK & BLUM will gladly quote on your requirements . . . one or a thousand units . . . any size. Send prints and specifications to the Kirk & Blum Manufacturing Co., 3230 Forrer Street, Cincinnati 9, Ohio.

• CONTROL DESKS and PANELS • SWITCH GEAR HOUSINGS
• CUBICLES • TRANSFORMER HOUSINGS and TANKS
• ELECTRICAL ENCLOSURES • MACHINE BASES
• VENTILATING LOUVRES

For Industry

Power Plants

and Utilities



A free booklet, "Sheet Metal Assemblies" lists Kirk & Blum facilities for fabricating metals up to ⅜″. Write for your copy.

KIRK & BLUM

For more data circle 508 on Post Card

Hall Industrial Water Report

VOLUME 3 DECEMBER 1955 NUMBER 6

It Takes a Lot of Water to Process Food

In this 60-billion-dollar-a-year business, Hall helps to keep production up by keeping troubles with water down in plants from Massachusetts to California and from Florida to Washington. Not only the conditioning of water for steam power and steam heating, for cooling and for cleaning and processing, but also the processing of waste water for re-use, requires expert consultation and continuing service.

Maintenance Reduced in Plant Condensate System

Severe corrosion was being experienced throughout the condensate system of an Eastern chocolate manufacturing plant, with periodic replacement of sections of return line. Robert Dow, service engineer in the Boston office of Hall Laboratories, suggested a survey with corrosion test specimens to determine how much the use of Hagafilm® might improve conditions.

Weight losses on the test specimens before treatment revealed corrosion rates in most of the return lines sufficiently high to justify treatment. Simple gravity feed of Hagafilm to the boiler feedwater at the suction side of the boiler feed pump was accordingly started.

During the first three months, old corrosion products loosened by the action of the filming amine occasionally plugged traps and strainers. Then the intervals between maintenance calls lengthened until six months would elapse without a single call for a trap to be cleaned or a corroded pipe fitting to be replaced.

When Bob Dow suggested further tests with specimens to measure the effectiveness of the Hagafilm, plant personnel said they already had all the evidence they needed.

Sweetened Boiler Water Not to Plant's Taste

A call for help reached Hall engineer Robert Hobek from a fruit processing plant in Kentucky. Carry-over from a boiler suggested that a slug of sugar syrup had somehow leaked into the condensate return system.

Steam coils used to heat some of the processing vats were immediately suspected, since the vacuum created when the steam was shut off could suck the liquid from a vat through any leak in the coil. A careful check revealed the expected perforation in one of the coils. This was repaired and all other coils were checked.

Most of the cooking was done with jacketed kettles so a drain valve was installed on each steam jacket, to be left open at the end of each day. In the morning the steam inlet valve to each jacket was partially opened and the first condensate running out of the drain valve was checked visually for any color indicating contamination.

Jacketed equipment is now used exclusively in the plant. No further difficulty with the sweetened boiler water has been experienced.

Fungus Attack on Cooling Tower Stopped

A mossy organic growth found in patches above the spray line in the top of their cooling tower was cause for concern to an Eastern food processing plant. Hall Laboratories' representative Jack White hurried samples to Hall headquarters in Pittsburgh for examination.

Out of the laboratory came the report that the damaged wood was infected with the same destructive fungus which had played havoc with a number of cooling towers in the Gulf Coast area, in one instance to the extent of $100,000 a year for replacement of wood.

Quick direct treatment of the wood was necessary. Hall engineer Ed Stewart arranged to have the plant personnel spray the cooling tower three times in a month with a trichlorphenate compound, soaking the wood thoroughly each time. An inspection then showed no signs of fungus attack in the zone where previously it had been severe. The plant has continued to spray the tower periodically with excellent results. No sign of fungus attack has yet appeared on a test board installed in 1953.

Plants which are not able to shut down periodically for spraying can protect the wood for prolonged periods by treating it successively with two water-soluble chemicals which interact to form a precipitate with fungicidal properties deep within the wood.

Hall Helps Hams

Hottest development in the curing of hams is an invention by G. O. Hall of Hall Laboratories described in U. S. Patent 2,513,094, now being developed commercially by Calgon, Inc., under the trade-mark Curafos.® By the properly controlled use of complex phosphates in the pumping pickle injected into the ham to produce the cure, the meat will retain its attractive color even when sliced and exposed to fluorescent lights at retail meat counters.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information, write, wire or call Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

Water is your industry's most important raw material. Use it wisely.

Hall Laboratories, Inc.—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

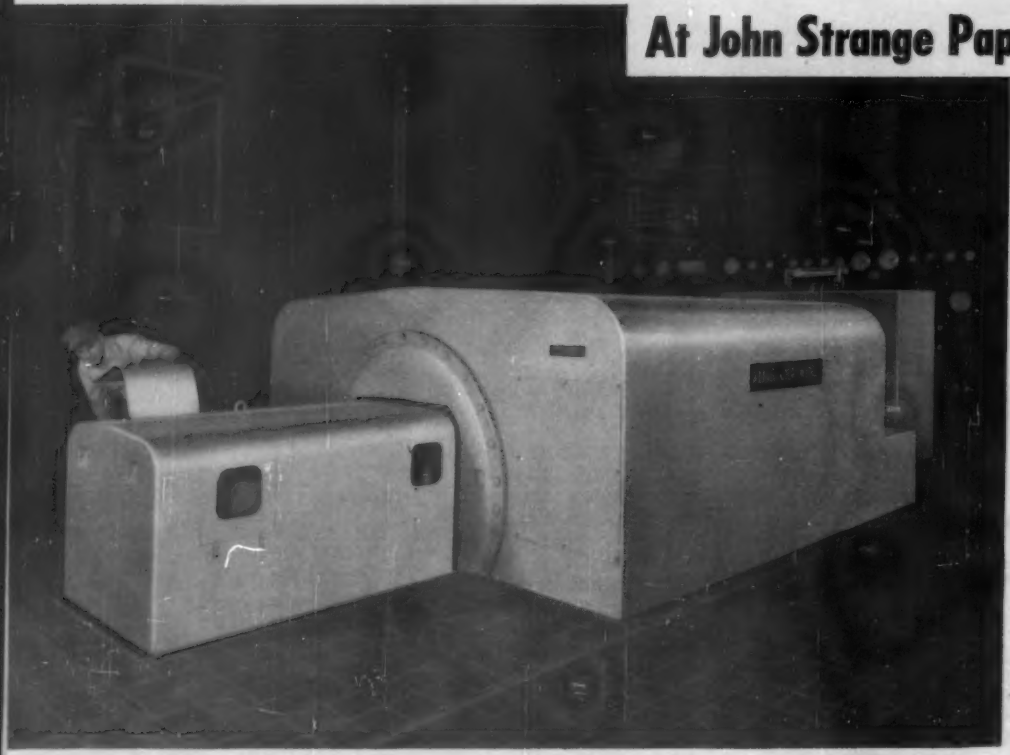
For more data circle 509 on Post Card

Paper Mills Choose for

WA-Series
STEAM TURBINE GENERATOR UNITS

Produce Economical Plant Power as By-Product from Process Steam

At John Strange Paper Company



MENASHA, WISCONSIN

5000-kw WA-Series unit produces power at 2400/4160 volts as a by-product of 150,000 lb per hour of process steam. Steam conditions at the turbine are 700 psig, 825 F, with 50 psig exhaust.

ALLIS-

Allis-Chalmers Units Power Generation

The paper industry is a good example of many industries across the country that are choosing modern Allis-Chalmers WA-Series steam turbine generating units for plant power generation. Many installations are already operating in NEMA ratings from 2000 to 7500 kw. Recently, the line was extended to 16,500 kw in AIEE-ASME preferred ratings.

WA-Series units are available for condensing or non-condensing service, with or without automatic extraction, providing the kind of advanced design that power producers want. Basic engineering features include labyrinth steam seals throughout, removable external glands, high chrome alloy steel buckets, and a time-proved governing system.

Engineered to Save Installation Costs

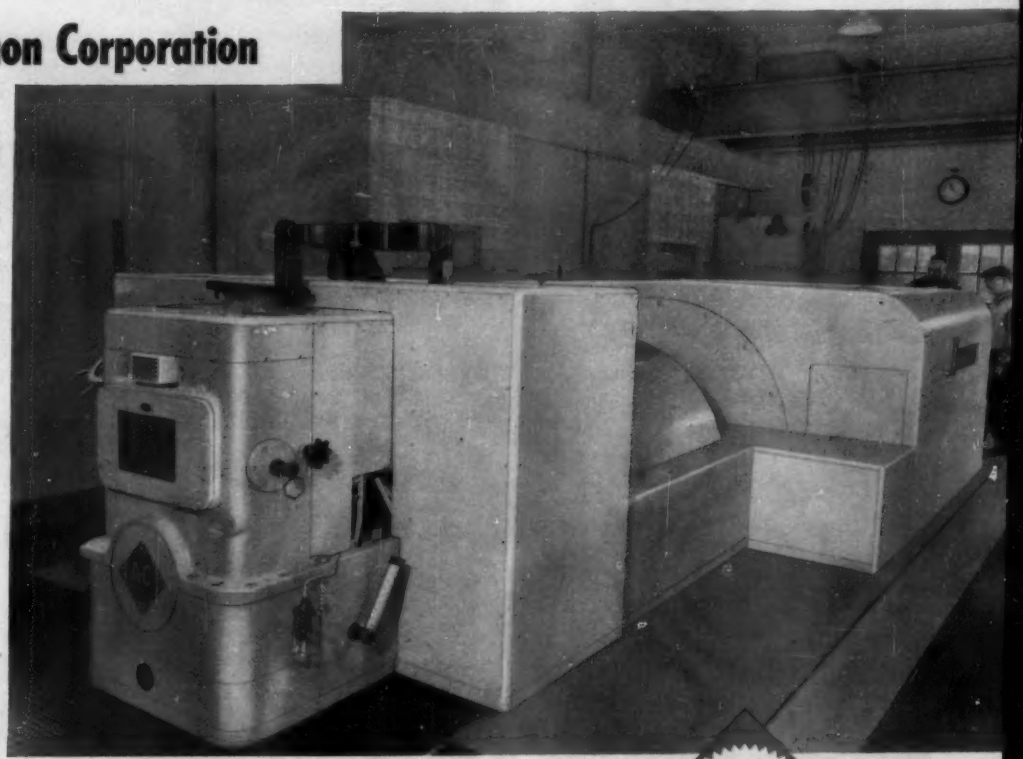
Particular care has been taken to promote ease of installation. Oil piping is above the floor line, eliminating need for trenches in the foundation. Generator gas coolers are located above the floor, eliminating ductwork through the foundation. Much of the work formerly done in the field is now performed in the factory. As a result, both turbine and generator can be shipped assembled ready for immediate installation.

For a detailed story on the advantages you can obtain with Allis-Chalmers steam turbine generating units, call your nearby A-C office, or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin, for Bulletin 03B7654. A-4868

At Marathon Corporation

ROTHSCHILD, WISCONSIN

4000-kw WA-Series unit produces power at 2400/4160 volts as a by-product of approximately 100,000 lb per hour of process steam. Steam conditions at turbine: 600 psig, 825 F, with 40 psig exhaust.



CHALMERS

A-C ALLIS-CHALMERS

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Performance-- Value...

FIG. 16003—600-Pound Steel Pressure Seal Gate Valve.

FIG. 6061 WE—600-Pound Stainless Steel Swing Check Valve.

. . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . .

FIG. 3003 WE—Steel Gate Valve for 300 Pounds W.S.P.

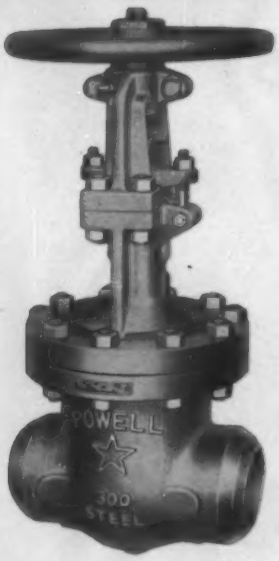


FIG. 1793—Iron Body, Bronze Mounted, Gate Valve For 125 Pounds W.P.

Powell Valves

You can depend on outstanding *performance* from every valve made by The Wm. Powell Company, for Powell Valves have a proven record of long life and dependable service.

And Powell Valves give you better *value!* They're precision made and incorporate many quality features—features that can save you money and give you lasting flow control.

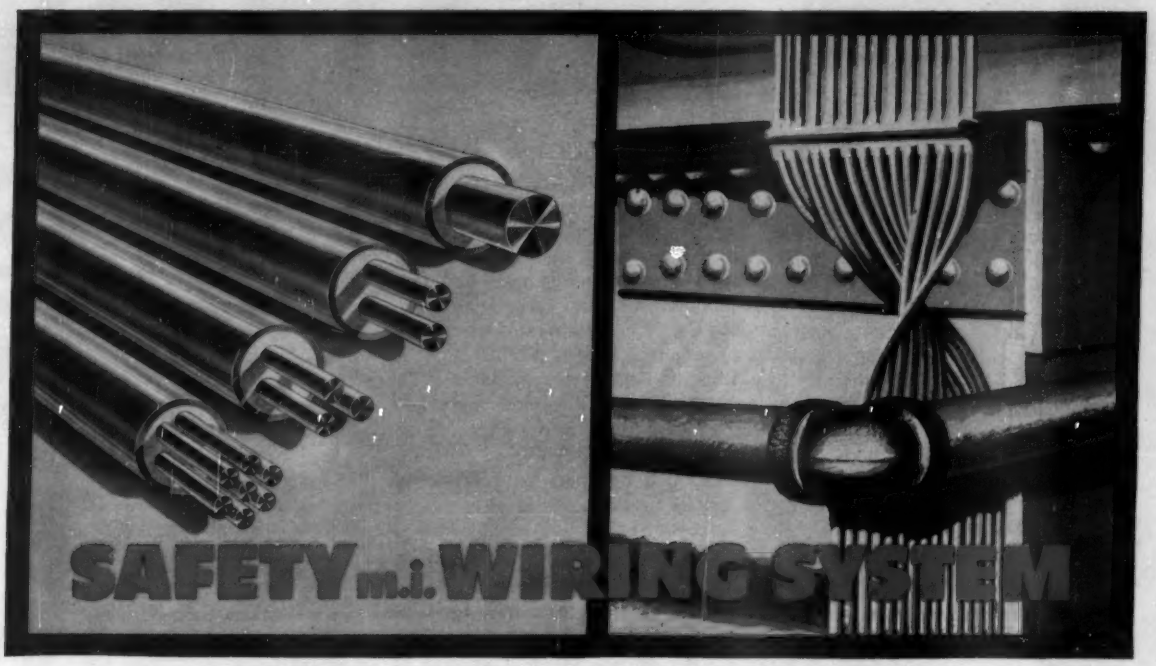
Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our *COMPLETE quality line*, and help solve any flow control problem you may have.

The Wm. Powell Company, Cincinnati 22, Ohio . . . . . 109th year

For more data circle 511 on Post Card

GENERAL CABLE

THE GREATEST NAME IN ELECTRICAL WIRE AND CABLE



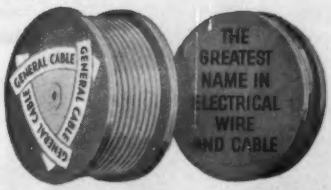
A dramatic new advance in electrical wiring for all applications up to 600 volts and wherever heat, vapors, moisture and aging are problems. Safety m.i. Wiring is ideal for low voltage, lighting, power, control, machine tool and equipment uses.

The mineral insulation of Safety m.i. Wiring is physically stable up to 2800° Centigrade . . . will not burn, deteriorate, support combustion, or convey flame . . . provides extra safety in boiler rooms, around steam pipes, boiler stacks and other "hot spots." Simple fittings seal both ends of wiring runs . . . no possible entrance for moisture.

Underwriters' Approved Safety (Type m.i.) Wiring Systems offers lower installation and maintenance costs. Acts as its own conduit . . . can be installed in one operation with standard switch and junction boxes. Easily shaped on the job, Safety m.i. can be fastened with standard clamps or straps . . . stays put permanently!

Save time and money! Get a neater job! Simplify planning! Ask your General Cable Representative for all the facts about Safety m.i. Wiring Systems. Remember, too, General Cable is the *only* manufacturer who can supply *all* your wire and cable needs!

GENERAL CABLE
CORPORATION



BARE, WEATHERPROOF, INSULATED WIRES and CABLES FOR EVERY ELECTRICAL PURPOSE

GENERAL CABLE CORPORATION
Executive Offices: 420 Lexington Ave., New York 17, N. Y.

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Today's

C-E STANDARD BOILERS

bring new standards of economy and reliability

If you need steam from 4,000 to 120,000 pounds per hour—or high-temperature water for heating or process applications—one of these versatile C-E Boilers will give you economical, standout performance.

Collectively, they offer you an exceptional diversity of choice. A brief consideration of the features of each will help you "pin-point" the design characteristics best suited to your situation. And remember: While they are standard in design *(which means lower first cost and proven performance)*, they are still *flexible* enough to be easily adapted to your exact requirements.

Of course, Combustion Boilers are available in other 2-drum designs . . . for capacities up to 350,000 lb of steam per hr . . . for pressures to 1375 psig . . . for temperatures to 960 F. . . . for any fuel or method of firing.

Please feel free to call upon us for further detailed information. Catalogs of each of the units shown here are available upon request.

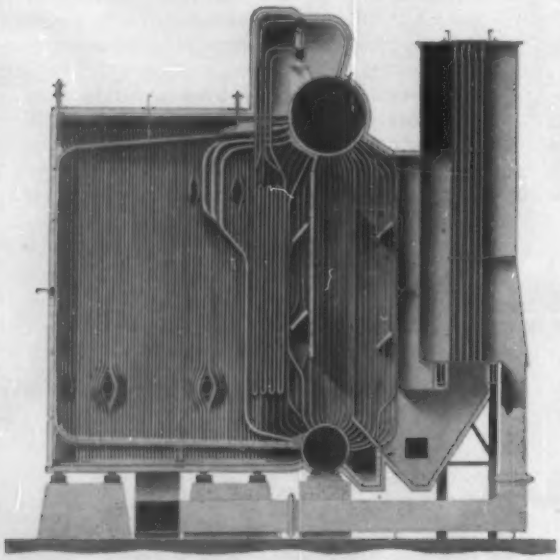
C-E

B-862

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.
Canada—Combustion Engineering-Superheater, Ltd., Montreal

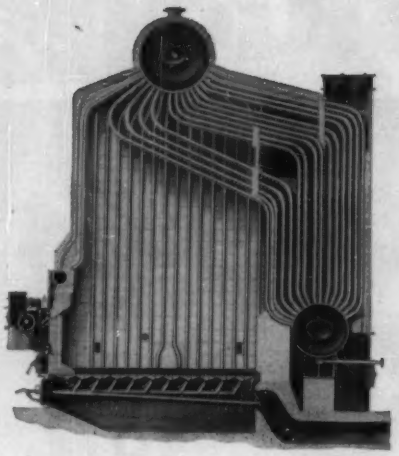
STEAM GENERATING UNITS; NUCLEAR REACTORS; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE



C-E Vertical-Unit Boiler, Type VU-55

Capacity—from 50,000 to 120,000 lb of steam per hr.

The VU-55 Boiler is available in six sizes and is designed for two pressure ranges—up to 250 psig and to 500 psig. These units are arranged for the application of superheater surface and heat recovery equipment if desired. VU-55 Boilers are designed for the pressure firing of oil or gaseous fuel and require no induced draft fan. They are equipped with tangential burners and tangent tube furnace walls to assure a level of performance which compares favorably with modern utility practice. The VU-55 Boiler is bottom supported, requiring no supporting steel structure. The absence of exterior ductwork permits a smooth, streamlined exterior which is both attractive and practical.



C-E Vertical-Unit Boiler, Type VU-10

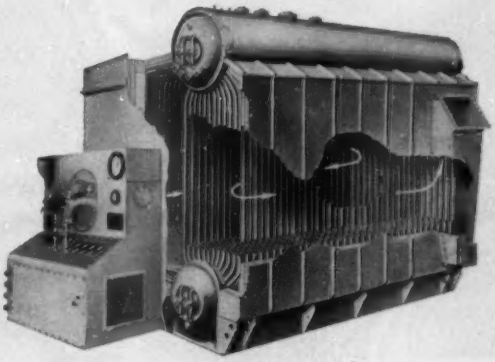
Capacity—from 10,000 to 60,000 lb of steam per hr.

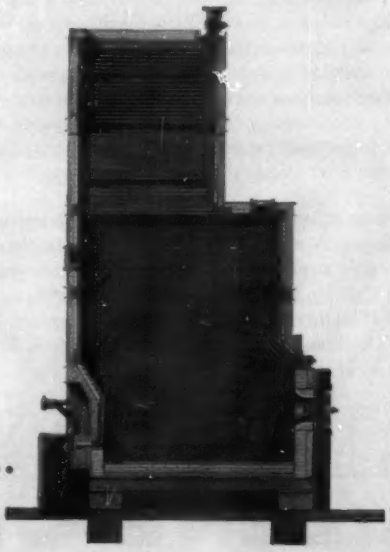
The VU-10 is available in nine sizes . . . for operating pressures up to 475 psi . . . superheat to 200 F in 20,000-60,000 lb range . . . for solid, liquid, or gaseous fuels. This boiler is a completely standardized design adaptable to many conditions. It is bottom-supported and needs no outside supporting steel. It operates efficiently over a wide range of output, and is easy to operate and to maintain. All parts are easily accessible for inspection. The VU-10 is a complete unit — boiler, furnace, setting, fuel-burning equipment, controls, forced draft, heat recovery equipment (if desired). Regardless of fuel, the same general cross-sectional arrangements of drums, convection bank and furnace wall cooling is used. Uniform design through each transverse section assures even water level in the drum and uniform expansion.

C-E Package Boiler, Type VP

Capacity—from 4,000 to 40,000 lb of steam per hr.

This completely shop-assembled boiler is available in fourteen sizes . . . for operating pressures up to 500 psi . . . for pressure firing of liquid or gaseous fuels. The VP Boiler has more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type. The large lower drum — 30-inch diameter — permits a simple, symmetrical tube arrangement . . . greater water storage capacity . . . easy access for washing down or inspection. A low speed centrifugal fan which is exceptionally quiet in operation is standard equipment. The simple baffle arrangement results in low draft loss . . . simple soot blowing . . . no dead pockets . . . high heat absorption. The VP is enclosed in a reinforced, gas-tight, welded steel casing, and shipped completely assembled with firing equipment, fittings and forced draft fan. For foundation, it needs only a simple concrete slab.





The New C-E La Mont Controlled Circulation Hot Water Boiler

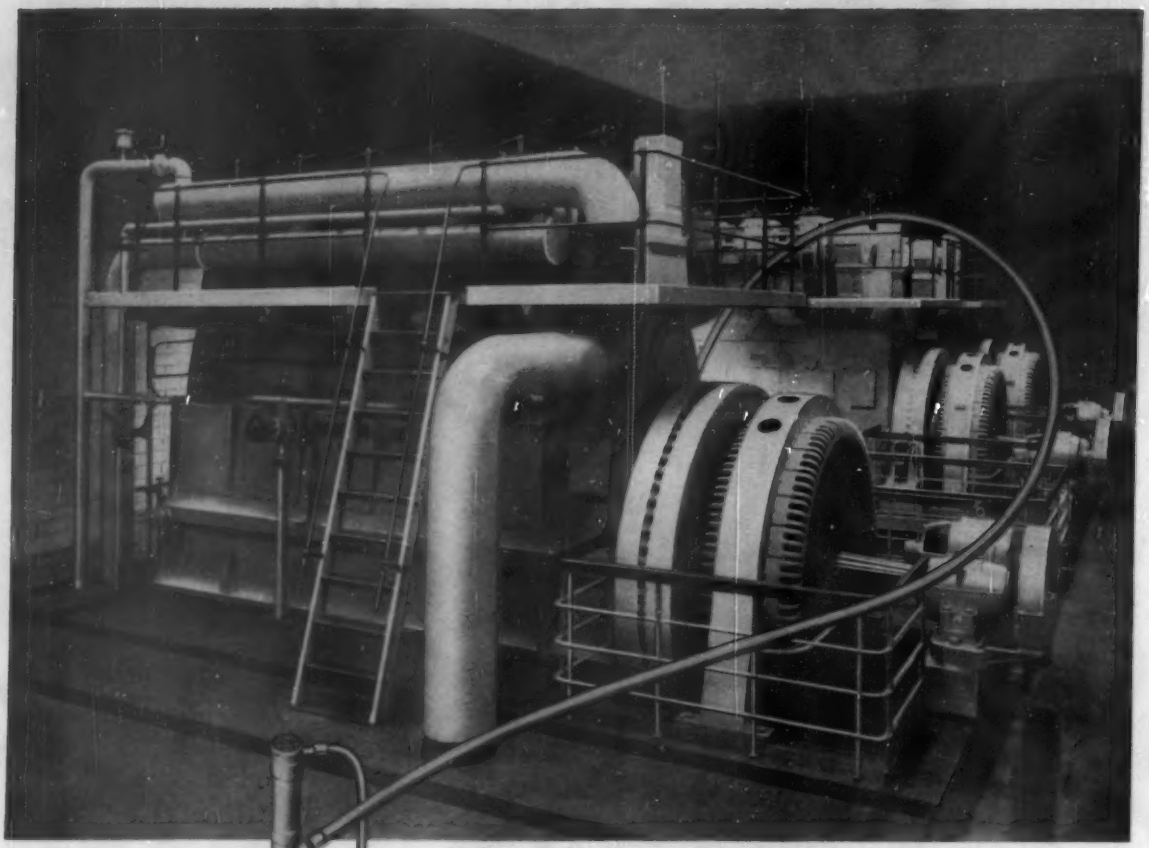
Capacities up to 200,000,000 Btu per hr.

For those applications where high temperature water has inherent advantages over steam—and there are many — the C-E La Mont HT Boiler has numerous points of superiority. Among the more important of these are:

1. **Complete control** over HT water movement in both system and boiler.
2. **Low pressure** loss is inherent so no separate boiler pump is required.
3. **Pressurized operation** with oil or gas means no induced draft fan — simple stack.
4. **Single-pass design** has no baffles—low draft loss—cleaner boiler.
5. **More efficient heating surface** can be arranged because of positive, controlled circulation.
6. **Other features** such as: steel enclosed setting — few headers, all accessible—any fuel, oil, gas or coal. For pressures to 300 psig and temperatures to about 425 F.

For more data circle 513 on Post Card

Stops Sludge!



Guard your Diesel against sludge and carbon deposits — switch to Sinclair RUBILENE®, the lubricating oil with over 35 years of proven performance. RUBILENE's top quality means protection against "stuck rings"— prevents excessive wear of cylinders, pistons and other vital moving parts operating continuously for long periods. Sinclair RUBILENE pays off in reduced maintenance and less work during overhauls. Your Diesel stays on the job longer!

Switch over to RUBILENE. Regardless of the age or make of your Diesel, there's a member of Sinclair's famous RUBILENE or RUBILENE H.D. family that meets your needs exactly! Call your local Sinclair Representative or write for free literature to Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. *There's no obligation.*

SINCLAIR

RUBILENE OILS

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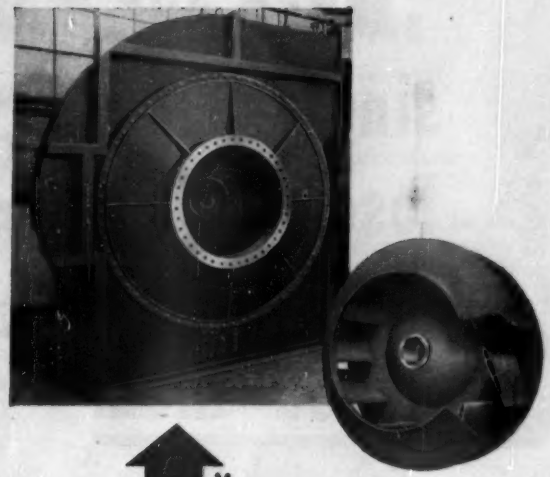
GREEN

Specialists in Equipment that MOVES AIR STOPS FLY ASH

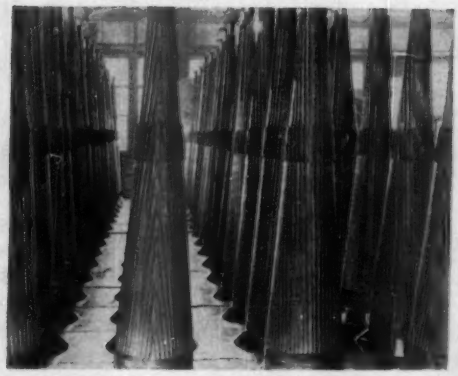


Two major items in the Green Line that have been enthusiastically accepted in the field are:

* **GALEX AIRFOIL TYPE DRAFT FAN**

AERODYNE

* **FLY ASH COLLECTOR**



The Galex Fan is available in 6 designs which provide highest static efficiency ratings over the widest range covered by any fan on the market. Let us send you a complete description of the fan, including performance data. Learn how the Galex offers surprising savings in annual operating costs of your installation.

The Aerodyne Collector recently solved another fly ash air pollution problem—for one of the largest utility plants in the country—at a minimum cost, in minimum time, with a minimum installation problem. If your installation involves flyash—or dust of any kind—it will pay you to investigate the simple, versatile, low cost Aerodyne system. Send us a brief outline of your operating conditions and our dust collection specialists will tell you precisely what the Aerodyne has to offer.

Green Power Plant Equipment has been serving industry in this country for more than fifty years. The Galex Fan and Aerodyne Collector are two more examples of progressive engineering which meets today's industrial and power plant requirements.

GREEN THE AIRFOIL TYPE FAN Galex FAN

THE GREEN FUEL ECONOMIZER COMPANY

POWER AND PROCESS PLANT EQUIPMENT

NEW YORK • CHICAGO • DETROIT

Representative in Principal Cities

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For more data circle 515 on Post Card

"When our main feeder single-phased, we did not lose a motor — FUSETRON DUAL-ELEMENT FUSES saved them"

"In October, 1952, we had quite a demonstration on how Fusetron dual-element fuses can prevent motor burn outs.

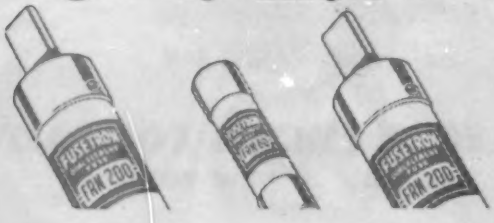
"Fusetron fuses that we were using to back up our motor protection began popping out all over the plant because our main feeder circuit had single-phased.

"Before we could dump the whole plant by pulling the main switch, sixty-seven Fusetron fuses had opened.

"We did not lose a single motor, however, and while it was some trouble to us to replace all the blown Fusetron fuses, we would rather do that than repair one burned out motor.

"We are convinced that Fusetron fuses used to back up our other motor protection, give us a distinct advantage in saving time and money.

Samuel T. Craig CHIEF ELECTRICAL ENGINEER
JUDSON L. THOMSON MANUFACTURING CO.
WALTHAM, MASSACHUSETTS



FUSETRON dual-element FUSES DO MORE THAN PROTECT MOTORS AGAINST BURNOUT DUE TO SINGLE PHASING

. . . *They provide 10 Point Protection*

1. High interrupting capacity — protect against heaviest short-circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes.

2. Protect against needless blows caused by excessive heating — lesser resistance results in cooler operation.

3. Protect against needless blows caused by harmless overloads.

4. Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5. Protect against waste of space and money — permit use of proper size switches and panels.

6. Protect motors against burnout from overloads.

7. Give DOUBLE burnout protection to large motors — without extra cost.

8. Protect motors against burnout due to single phasing.

9. Make protection of small motors simple and inexpensive.

10. Protect coils, transformers and solenoids against burnout.

AND FUSETRON FUSES REMAIN SAFE

without maintenance and recalibration costs

Once properly installed, Fusetron fuses require no costly inspection time or maintenance necessary on mechanically operated devices.

Dust, fumes, corrosion or age cannot prevent a Fusetron fuse from opening safely. There are no hinges, pivots or contacts to stick or slow down the operation of the fuse on short-circuit.

When a Fusetron fuse does open to protect, and after the fault has been corrected — the new Fusetron fuse you install has been calibrated at the factory by engineers — it is a fuse as safe and dependable as the one that blew.

Blowing time charts and more information are available on Fusetron dual-element fuses. Write for bulletin FIS.

FOR LOADS ABOVE 600 AND UP TO 5,000 AMPS . . . *Use BUSS Hi-Cap Fuses*

On 600 volts or less, they have interrupting capacity sufficient to handle any fault current regardless of system growth.

When coordinated with Fusetron fuses they will not open ahead of fuse nearest fault.

— Write for bulletin HCS —

Play Safe! *Install FUSETRON Fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!*

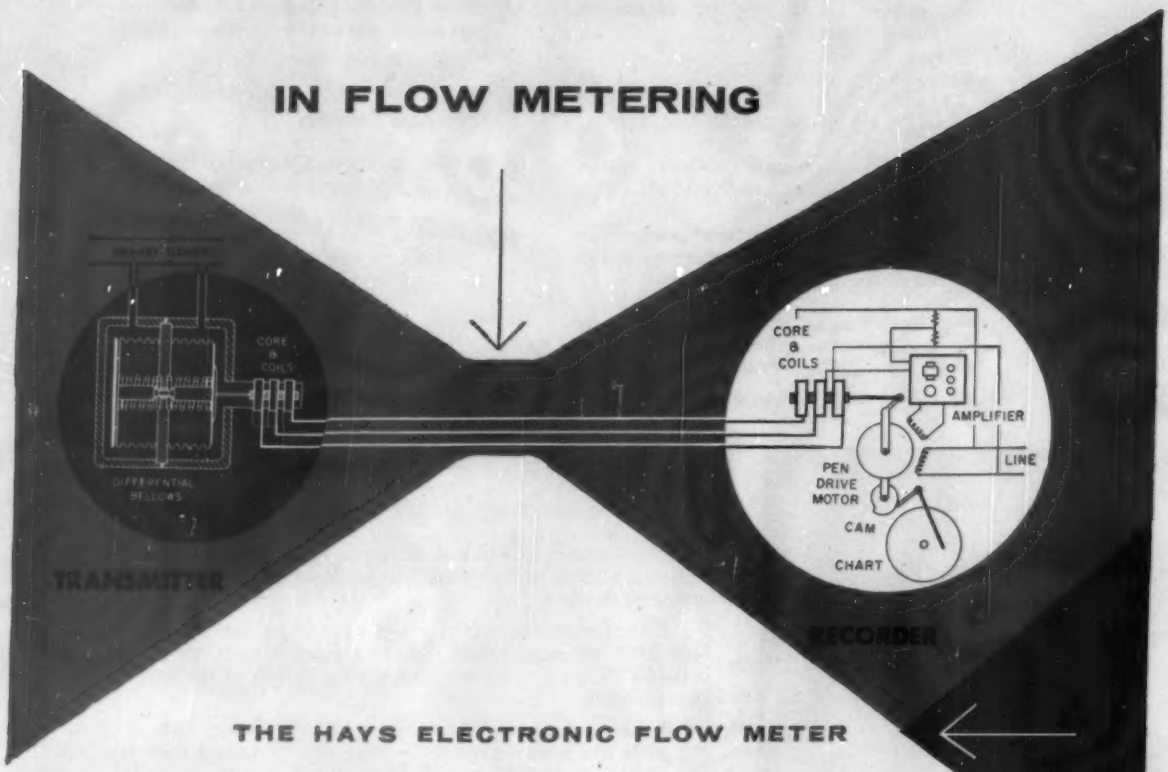
FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

BUSSMANN Mfg. Co. *Division of McGraw Electric Co.*
University at Jefferson, ST. LOUIS 7, MO.

For more data circle 516 on Post Card

new dimensions

IN FLOW METERING



THE HAYS ELECTRONIC FLOW METER

hays
CORPORATION
MICHIGAN CITY 7, INDIANA

Automatic Combustion Control • Vari-flow Meters and Varitrol • Electronic Oxygen Recorders • CO_2 Recorders Boiler Panels • Gas Analyzers • Combustion Test Sets Draft Gages • Electronic Flowmeters • Miniature Remote Indicators • Electronic Feed Water Controls

Here is a new Flow Meter—that is really new! These features of the Hays Electronic Flow Meter speak for themselves.

Mercuryless—costly mercury maintenance headaches eliminated—no mercury to lose.

Rupture-proof Bellows—provide positive protection against over-range.

Continuous integration—motor-driven continuous mechanical integrator is extremely accurate even on rapid load changes.

Electronic operation—requires only 4 seconds for full scale pen travel with accuracy of ¼% of full scale differential.

Other features include null-balance transmission, powerful motor, easy readability, accuracy unaffected by normal temperature changes. Explosion proof transmitters and wide range meters also available.

For complete information, write for Bulletin 54-1074-222.

For more data circle 517 on Post Card

HELPFUL BULLETINS

VALVES, PIPING FITTINGS

101 Valve Selection Tables — This valve selection chart features helpful selection data on forged needle valves, bar stock valves, and toggle valves. Includes specifications, typical uses, dimensions, and mounting tips, a valve sizing table and a corrosion resistance table. Hoke Inc.

102 Butterfly Valves — Bulletin 650-LIB describes butterfly valves, offering minimum space requirements, droptight performance and meeting AWWA design specifications. In addition to containing descriptive product and installation photos, bulletin includes design information on valve sizes, components, type operators, accessories, and lists other advantages. Builders-Providence, Inc.

103 Flush Valves — Flush valve pictorial package repair kits, plumbing specialties and key maintenance items are described in this 32-pp illustrated catalog. Includes cross sectional views of a complete line of popular flush valves. Assemblies and parts of each assembly are identified and part numbers given. Names of all the parts are listed beside part numbers in a table below cross sectional view. Crest Mfg. Co.

104 Air Valves — Tabulated data on company's line of manually operated air valves from 0 to 4000 psi is offered in Bulletin A-5. Includes ordering data, valve characteristics and dimensions, as well as photos of models described in bulletin. Barksdale Valves.

105 Valve Charts — Now available to power engineers are three well-organized wall charts on valve types, selection and protection. "How to know valves" covers four main types of valves from the standpoints of their appearance, inside construction, service intended, operation and use. "How to select valves" discusses five major factors involved in the choice of a valve —fluid, temperature, pressure, size, and function. "How to protect valves" — written in "do and don't" style covers 11 important points in valve installation, operation and maintenance. R-P & C Valve Div., American Chain & Cable Co., Inc.

106 Oil Valves — Bulletin 0-5 describes manually operated oil valves, rated 0 to 6000 psi. Gives valve characteristics, flow patterns, overall dimensions, ordering data. Photos of all models are provided. Barksdale Valves.

107 Flexible Ball Joint — Catalog 215-B, 20-pp, describes advantages of company's flexible ball joints for use in piping for power, process, heating, chemical, construction, or hydraulic service. Includes engineering specifications and data on the standard 300 lb series and the series 600. Screwed, flanged and welding end joints are listed, as are insulating joints and jacketed joints for handling asphalt and other liquids that solidify unless heated. Barco Mfg. Co.

108 Impervious Graphite Equipment — Impervite pipe, fittings and valves are described in 12-pp Catalog 965. Covers operating and dimensional specifications of Impervite. For comparative purposes physical properties are charted for graphite, Impervite (resin impregnated graphite) and Graph-i-tite (carbon impregnated graphite). Also provided is section on methods of connection, telling how to cut threads, serrate and cement pipe on the job with portable tools. Falls Industries, Inc.

HOSE, COUPLINGS

109 For High Pressures — Bulletin 3040-A, 12 pp, describes Hi-Duty pressure hose and reusable couplings, giving their advantages and applications. Provides specifications and illustrated assembly instructions for cotton-covered and rubber-covered hose, and couplings; also data on adapter unions, and flare fittings. The Imperial Brass Mfg. Co.

110 Flexible Metal Hose — Bulletin 20-E describes flexible metal hose of annular helical construction. Steel and bronze hose, with and without wire braid, couplings and assemblies are described. Engineering data inclusive of bending radii, bursting pressures, weights is given, and various applications are listed. Atlantic Metal Hose Co., Inc.

PUMPS AND COMPRESSORS

111 For Heavy Duty Pumping — Eight-pp Bulletin H-2 introduces a low-cost gear pump, the Hydrex, for heavy duty pumping applications. Illustrates construction features and explains how simplified design contributes to reduced pumping costs. Typical applications of these 1 to 350 gpm pumps in power plant, chemical, petroleum and corrosive service are pictured. Full data on sizes and capacities are also given. Sier-Bath Gear & Pump Co., Inc.

112 Water Circulating Pumps — Bulletin HC-855 features a type of centrifugal pump made especially for large circulating water systems where smooth and silent operation is required. Shows how pump can be used to boost city water pressure in tall buildings. Includes diagrams and a table showing sizes and dimensions. Bell & Gossett Co.

113 Boiler Feed Pump — Bulletin 08B7899, 16-pp, describes design features and principal advantages of company's barrel type boiler feed pumps. Shows why balanced thrust design gives radial and axial balance for greatest reliability and for smooth operation and longer pump life. Allis-Chalmers Mfg. Co.

114 Pumps for Oil Industry — Section G, 14-pp, of company's catalog on rotary pumps describes pumps designed for the oil industry. Includes chart on the selection of proper materials and describes standard twin and multiple units, all weather twin and multiple units, and truck mounting pumps. Photos, diagrams, tables of dimensions and specifications complete the booklet. Viking Pump Co.

115 Improved Compressor — Publication B-154 gives engineering details and technical specifications of a compactly designed product for handling air or any other gas under either pressure or vacuum. Explains how this blower works and includes cutaway photo of interlocking main and gate rotor assemblies; sectional diagram of component parts; performance charts. Read Standard Corp.

MECHANICAL POWER TRANSMISSION

116 Speed Reducers — Design and operation advantages of company's line of Torque-Arm speed reducers are outlined in 28-pp Bulletin A-637. Includes selection tables for double and single reduction units, bore dimensions and bushings, data on overload releases, flange mounted speed reducers, and recommended V-belt drives. Dodge Mfg. Corp.

117 Electro-Magnetic Drive — Form WEB6194 LO-M, 8-pp, is an application analysis report covering 21 ways in which company's standard units can be applied to power transmission drives. A wide range of industries is covered. Points out advantages of electro-magnetic drive in providing faster, smoother starts and stops, infinite control of torque, and push-button actuation or automatic control. Warner Electric Brake & Clutch Co.

ELECTRICAL EQUIPMENT

119 Distribution Transformers — Bulletin 61B6159E, 16-pp, tells how electrical system operating conditions can be improved through use of company's distribution transformers. Tells how transformers make use of "Curvacore" construction. It describes coil, tank and bushing design and construction. Mechanical information as well as installation practice included. Allis-Chalmers Mfg. Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the Reader Service Cards page 117.

120 For Longer Motor Life — The Silco-Flex all-silicone rubber insulating system for motor and generator stator windings is discussed in Bulletin 05R8341. Explains superior electrical, thermal and mechanical properties and desirable chemical properties of the insulation. Allis-Chalmers Mfg. Co.

121 High Voltage Terminals — The metallizing process which makes possible hermetic seals capable of withstanding higher temperatures and severe thermal shock is described in Bulletin AVP-55-3 on high voltage terminals. Specifications, drawings and applications are included. Advanced Vacuum Products, Inc.

122 Control Relay — Eight-pp Bulletin PL 7305-PM describes company'

line of control relays, designed to occupy minimum panel space, and available in models with from two to 12 poles. Pictures 10 models, gives dimensions, enclosures, features, and data on maintenance and pole conversion from normally-open to normally-closed; as well as listing literature and template kits available. Clark Controller Co.

123 Magnetic Starters — Eight-pp Publication GEA-6301 describes a line of magnetic starters for air conditioning and refrigeration equipment. Gives features, ratings, and dimensions of the starters. Also contains wiring diagrams, installation requirements. General Electric Co.

124 Motive Power Batteries — This 48-pp general service manual on lead acid batteries for motive power application is a practical guide to industrial cycle service, including industrial truck, air conditioning and others. Includes photos, charts, tables, methods of repair, maintenance and theory of operation, instructions covering repairs with regular or special tools, simplified testing methods including safety practices, acid handling precautions, and correct charging methods. Manual is cross-indexed and includes suggested list of spare parts required to make repairs quickly. C & D Batteries, Inc.

125 Saturable Reactors — Eight-pp Bulletin GEA-6354 describes applications, models, and ratings of company's saturable reactors, discussing their theory and application as control equipment for individual power loads. General applications discussed include control of electrically heated equipment, automatic temperature stabilization, reduced-voltage motor starting, continuously adjustable reactive load banks. Bulletin contains wiring diagrams, ratings, dimensions and list prices. General Electric Co.

126 Test Equipment — Sixteen-pp Catalog R36A illustrates and describes instruments for servicing industrial electronic and electric equipment and communication equipment. Presents clamp ammeters, circuit testers, oscilloscope, voltmeter, volt-ohmmeter and other instruments. Gives features, ranges, and application suggestions. Weston Electrical Instrument Corp.

127 Service Drop Cables — Bulletin DM-5556, 8-pp, gives complete information on service drop cables with Neoprene or polyethylene insulation. Describes important features and includes tabulated data on dimensions for rubber, polyethylene and Neoprene insulation for aluminum and copper conductors. Anaconda Wire & Cable Co.

You'll save time in ordering bulletins by using the Reader Service Cards on page 117. Of course we honor letterhead requests—but it takes us somewhat longer to handle them.

128 Asbestos Insulation — This booklet of specifications, RSS No. 88, 8-pp, establishes performance tests for asbestos insulation applied as a felted wall in combination with varnished cambric tapes for lighting wires and power cables with 600 and 1000 v ratings. Measures the plus values of felted wall construction over and above industry standards for type AVA wires and cables. Test characteristics are covered. Rockbestos Products Corp.

129 Electrical Safety Markers — Bulletin 175 describes and pictures a line of self-sticking non-conductive conduit and voltage markers. Shows styles available, and provides photos of these markers in use for identifying conduits, busways, circuit breakers, control centers, switches, power lines, switchboards, transformers, utility switches and other types of electrical equipment. W. H. Brady Co.

METALS

131 Copper-Base Alloys — This 6-pp bulletin reviews prospective improvements in metallurgy and operating practices for non-ferrous foundrymen. Calls particular attention to corrosion resistance and strength of the actively developed manganese and aluminum bronzes and cupro-nickels. Bulletin also outlines a simple five-group classification for copper-base alloy castings. The International Nickel Co., Inc.

132 Ductile Iron — Cast iron that can be bent is described in this 28-pp Revised Edition, with tables, charts and photos. Photos show applications of ductile iron castings, and bulletin lists typical applications in various industrial fields. The International Nickel Co., Inc.

INSTRUMENTS AND CONTROLS

133 Service Regulators — Bulletin 1026, 20-pp, describes performance and design features of company's line of service regulators. Includes cutaway-illustrated description of regular and high-pressure regulators — both with 360-deg swivel connection assembly and side drain top covers. Rate-of-flow graphs illustrate maximum outlet pressure build-up and amount of gas relieved to atmosphere by extra-safety devices in case of failure of a service regulator. Meter and Valve Div., Rockwell Mfg. Co.

134 Practical Flow Measurement — Bulletin 115, 20 pp, describes and illustrates company's Full-View Rotameters designed for improved flow measurement and control. Safety glass shielding, and other design features are explained, as are metering tubes, floats and other components. Capacity charts, general dimensions are provided and materials of construction listed. Booklet also shows standard modifications; describes and pictures alarms and transmitters available. Brooks Rotameter Co.

135 Pneumatic Regulators — Eight-pp Bulletin H-2 lists company's complete line of precision-made pneumatic regulator equipment including: filter-regulator combinations, filters and regulators, relays, purge assemblies and control panels. Bulletin is illustrated with cross section and dimension drawings, and gives typical applications. Conoflow Corp.

136 Strip-Chart Recorders — Bulletin G-628, 12-pp, describes 6-in. strip-chart recorders for pressure, liquid level, temperature, flow, and mechanical motion. Contains installation drawings showing methods of applying instruments to different variables, as well as photos of various models and their features. Use of the recorder as a receiver for remotely generated signals, either pneumatic or electrical, is also described. The Bristol Co.

137 D-C Recorder — Product Specification E12-4, 12-pp, describes company's potentiometric receiver recorder and controller for temperature, pH, force and pressure, flow and level, speed, radioactive isotope detection, current, voltage, and power, and d-c sources. Covers design and operation features and includes schematic circuit diagram, performance data, and specifications. Bailey Meter Co.

138 Flow Controller — Bulletin 600-J9A describes a power actuated rate of flow controller for the effective operation of water, waste, or industrial plants. Lists advantages, describes component parts and operation, and includes specifications and installation diagrams. Builders-Providence, Inc.

NUCLEAR REACTORS

140 Nuclear Research Reactors — Bulletin GEA-6326A, 8-pp, discusses ways in which company's swimming pool reactor, water boiler reactor, heavy-water research reactor and nuclear test reactors can be utilized in industry, education and research. Describes characteristics of all four types and includes photos as well as application recommendations. General Electric Co.

141 Nuclear Test Reactor — Bulletin GEA-1123, 20-pp, depicts through description, drawings and photos the design features and construction of company's light-water and oil-moderated nuclear test reactor, using heterogeneous-enriched fuel. Includes numerous photos, diagrams and drawings. General Electric Co.

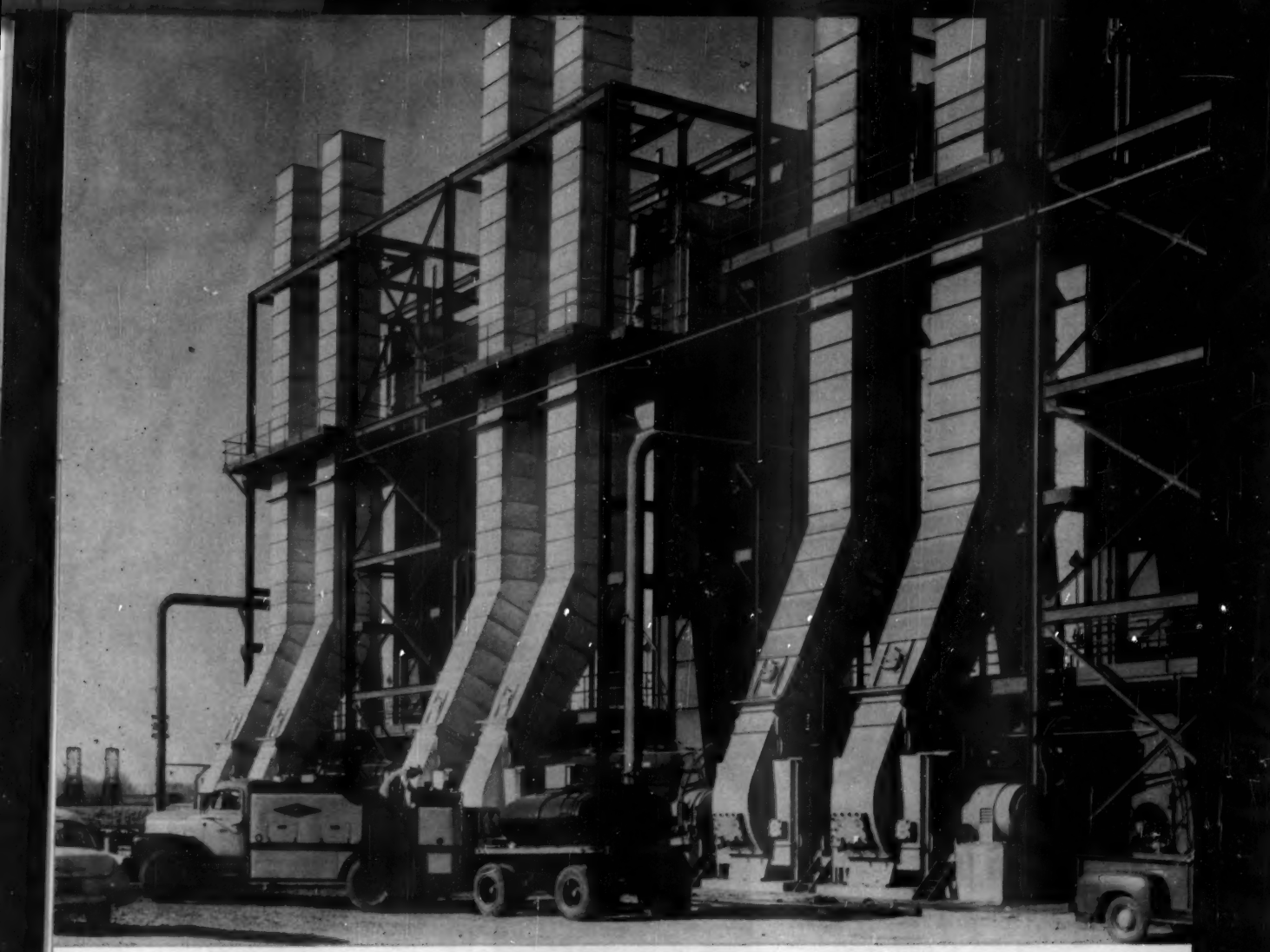
LUBRICANTS

142 Extreme Pressure Lubrication — Revised Bulletin 103A lists 17 types of molybdenum disulfide lubricants and features an explanation, with diagrams, of applications in extreme bearing pressure, and high, low and normal temperature lubrication. Five new lubricants are included. A selector chart describes each type, kind of carrier used in it, temperature range in which it operates best, and also describes method of application. The Alpha Molykote Corp.

143 Specialized Lubricants — Sixteen lubricants embodying processed molybdenum disulfide and providing dry, liquid, and grease-film lubrication are covered in this bulletin. Data on forms, diluents, temperature of application, uses are given in chart form. Also provided is general information on molybdenum disulfide lubricants. McGee Chemical Co., Inc.

144 Vapor Spray Lubricant — Bulletin L-8 describes the applications of a vapor spray lubricant called Micro-Moly. Lists functions and purposes as a dry lubricant which provides a protective undercoating for applications where oil and grease are used, resists corrosion, and reduces scuffing, galling, scoring or seizing. Tower Oil Co.

145 Waxes, Oils, Greases — Chemical structure, specifications, properties, applications and general description of a new group of fluorocarbon oils, waxes and greases for industrial use are given in this 16-pp booklet. Among applications suggested are hydraulic pumps, pump fluids, damping fluids, heat transfer media, permanent lubricants. Booklet also discusses color and clarity, viscosity, specific grav-



BOILER TUBE FAILURES ELIMINATED

Regular program of DOWELL chemical cleaning for six boilers ended tube failures due to scale

The tubes of a 500,000 pph boiler in a chemical plant contained an extremely hard high-silicate scale up to ¼-inch thick. Mechanical cleaning was unsatisfactory, because it required a long shutdown and still left hard scale in the tubes.

Dowell engineers formulated a special solvent and quickly removed the scale from the boiler. The operator now has all six of the 500,000 pph boilers on a regular schedule of Dowell chemical cleaning. Since the beginning of this program, the boilers have been cleaned several times and there have been no tube failures caused by scale deposits.

Chemical cleaning is designed to add years of life to your equipment by helping to protect it from over-heating, galvanic attack, and pitting-type corrosion. Downtime is held to a minimum, because solvents are introduced through regular connections . . . extensive dismantling and scaffolding are not needed.

Dowell Service brings you over a decade of experience in the chemical cleaning of many kinds of equipment, including more than 10,000 high- and low-pressure boilers. Contact the nearest Dowell office for more information. Or write Dowell Incorporated, Tulsa 1, Oklahoma, Dept. L-24.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

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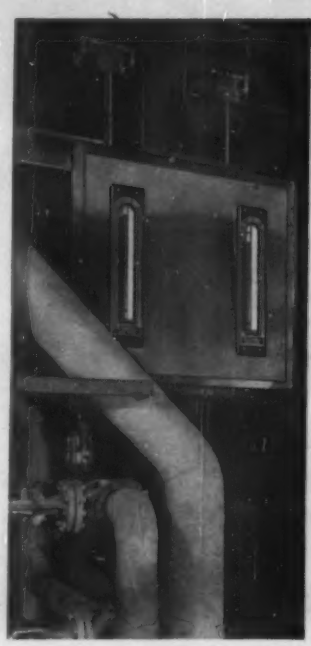
Sure way to double check vital boiler water levels — install Reliance EYE-HYE Remote Reading Gage

It's fine to have automatic controls, but be sure you have the important safeguards against possible failure — adequate *maintenance* and *cross-checks.*

EYE-HYE is your reliable cross-check for *boiler water levels.* A manometric-type remote reading gage, it keeps operators informed on water level status. Easier to read than conventional gages, although it's the same familiar form — a vertical column of liquid. EYE-HYE's indicating fluid is a pleasing green that "pops out", brightly illuminated from the rear.

You can place EYE-HYE any reasonable distance from the drum — above or below it, on wall or instrument panel. Easy to install and maintain — no mechanical working parts — no adjustments on location. Write for Bulletin CO and learn how EYE-HYE can increase the efficiency of *all* your water levels.



How one user checks water levels in surge tank and feed water heater with long type EYE-HYEs. (Face plate can be calibrated at factory.)

The Reliance Gauge Column Company
5902 Carnegie Avenue • Cleveland 3, Ohio

For more data circle 519 on Post Card

ity, surface tension, flammability, other qualities. Chemical Mfg. Div., The M. W. Kellogg Co.

. . . Outstanding Among This Month's Catalogs

146 Handbook of Hydraulic Tables — Bulletin 50 is a 28-pp handbook of hydraulic tables and engineering data. Covers accumulators, boiler feed, cylinder capacities, circumferences and areas of circles, conversion tables, displacement per stroke, equivalents, electrical formulae, friction loss, water pounds per gallon vs temperature, recommended materials, pressure, temperature conversion, other facts — all in convenient tabulated form. The Aldrich Pump Co.

147 Raceways and Fittings — Many new fittings are presented in Catalog and Wiring Guide 20, a 132-pp pocket size manual and ordering booklet. Generously illustrated with photos and sketches, this practical booklet includes dimensions, descriptions and wire capacities of raceways, and pertinent data on fittings and accessories for use with them. Similar information is provided for overfloor wiring systems, surface wiring systems and multi-outlet systems, and interconnecting fittings. Installation suggestions are given and fastening procedures are included. The Wiremold Co.

148 Muscles For Industry — Pneumatic power positioners, to provide the "muscles" for thousands of exacting control loads are described in this packet of specification sheets, Bulletin TP-MF1. Individual sheets describe performance and construction specifications for standard positioner models, designed for applications where thrust and positioning accuracy requirements are severe — to control flow, pressure, temperature, or level by operating valves, gates, or dampers. Covers positioner cylinder sizes from 4 by 5 in. to 12 by 48 in. Hagan Corp.

BOILERS, GENERATORS

150 Heating Boilers — Revised Catalog S-55 shows company's low pressure heating boilers in two series: the 500 for automatic firing of oil, gas or coal; the H-500 for hand fired coal. Cross section installation and dimensional views with complete engineering data for 19 standard sizes make this a useful reference book. Erie City Iron Works.

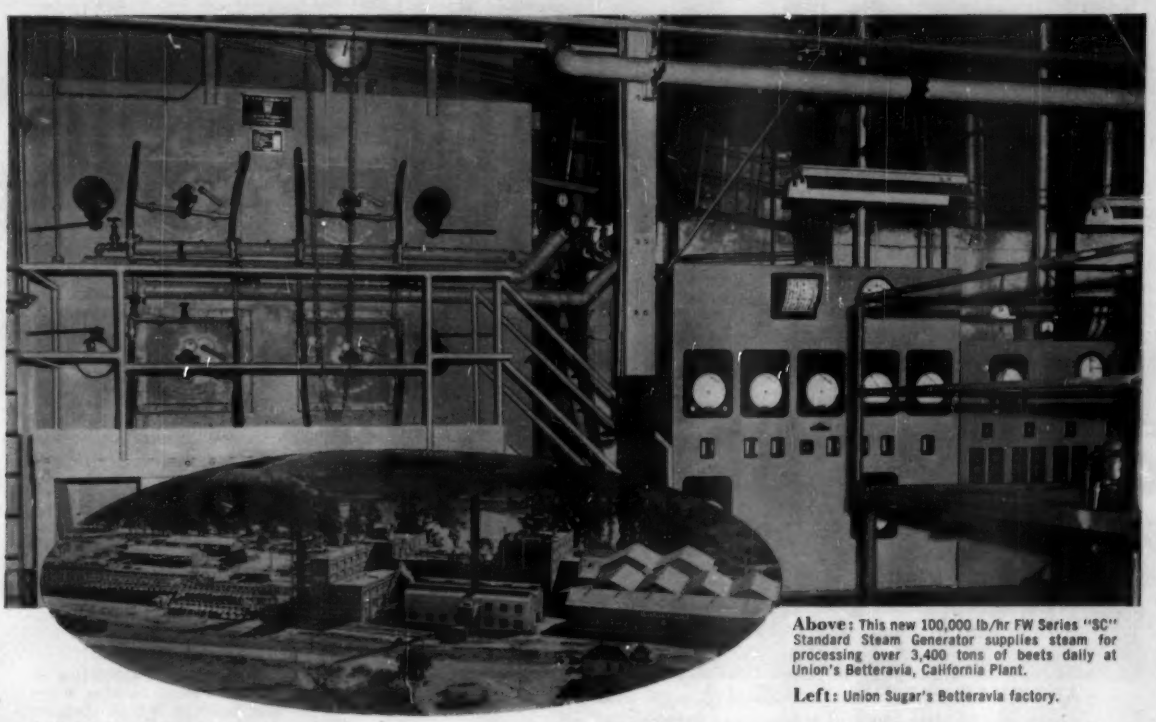
151 Steam Generator — Bulletin PSG-2, 10-pp, describes design and construction details of company's line of package unit steam generators. Includes photos, diagrams, and table listing capacities, dimensions and weights. Henry Vogt Machine Co.

OTHER EQUIPMENT

152 Turbocharged Engines — Advantages of turbocharging are discussed in color-illustrated 16-pp Bulletin 12009. Describes five Turbodiesels, points out such advantages as greater fuel economy, more power without increased size, and reduced engine weight per horsepower.

Union Sugar

obtains low-cost steam



Above: This new 100,000 lb/hr FW Series "SC" Standard Steam Generator supplies steam for processing over 3,400 tons of beets daily at Union's Betteravia, California Plant.

Left: Union Sugar's Betteravia factory.

with a new

FW Series "SC" steam generator

This new Foster Wheeler "SC" Series Standard Steam Generator is a part of a continuing modernization and expansion program being carried on by the Union Sugar Division of Consolidated Foods Corporation, a pioneer California beet sugar company.

In selecting this unit, Union has taken advantage of the latest development by Foster Wheeler toward the reduction of industrial steam costs. This new generator embodies advanced design features which result in low installation, operating and maintenance expenses.

Maximum dependability under continuous full-load is assured by such advantages as: completely water-cooled furnace, fully drainable superheater, highly efficient boiler surface arrangement, and unrestricted circulation. The design also provides flexibility in heat recovery equipment, balanced or pressurized firing and steam purifying systems.

Fuels: Oil or gas—*Steam Temperatures:* Saturated to 950F—*Capacities:* 50,000 to 150,000 lb/hr—*Pressures:* to 1500 psi.

For complete information, write for Bulletin B 55-4, *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

For more data circle 520 on Post Card

When **HEAT** or **CORROSION** Add to Your Pressure Piping Problems . . .

Protect Pipe Joints with . . .

WATSON-STILLMAN FORGED STAINLESS or ALLOY STEEL FITTINGS

IN CORROSIVE SERVICE your pipe joints take a beating—fluid velocity and turbulence accelerate corrosion wherever there is a change in direction of flow.

AT HIGH TEMPERATURES structural changes in the metal can cause loss of strength and subsequent failure.

Those are good reasons for "playing it safe" in high pressure service with W-S Forged Stainless or Alloy Steel Pipe Fittings. W-S Stainless Fittings resist corrosion in a wide variety of process liquids and gases and high temperature steam. Available in Types 304, 316 and 304 L.

W-S Alloy Steel Fittings resist oxidation and graphitization and retain their high strength in high pressure—high temperature steam lines. Three alloys available—1¼% Chrome-½% Molybdenum and 2¼% Chrome-1% Molybdenum and 4-6% Chrome-½% Molybdenum.

W-S Forged Stainless and Alloy Steel Fittings can be obtained in Screw-End Type for 2,000 lb., 3,000 lb., and 6,000 lb. WOG service; Socket-Welding Type for Schedules 40, 80, 160 and Double-Extra Heavy Pipe. Send today for bulletin S-1-55.

Sold Through Leading Distributors

WATSON-STILLMAN FITTINGS DIVISION

H. K. PORTER COMPANY, INC.

Roselle, N. J.

For more data circle 521 on Post Card

Numerous photos are included, as well as charts plotting torque, horsepower and fuel consumption information. Cummins Engine Co., Inc.

153 Drafting Templates — Sixty-four drafting templates, grouped into convenient categories, are listed in this illustrated 12-pp catalog. Includes templates of a general nature such as the circle, diamond and triangle templates, in addition to ellipse templates, those for the mechanical engineering field, process templates, electrical templates, as well as miscellaneous templates and guide stone gages. RapiDesign, Inc.

154 Pipe Tools — This 8-pp revised quick-reference catalog presents recent changes in company's products which include improvements on their 26-R and 28-R Threaders; a new lightweight ratchet threader; a remodeled and redesigned high speed portable pipe machine; a power grip chuck; a quadra-type diehead; and a power drive, as well as a quick-opening threader. Beaver Pipe Tools, Inc.

155 Sluice Gate — Catalog 75, 12-pp, describes company's HY-Q flush bottom closure sluice gate, showing details of construction, installation, and operation in water filtration plants, power plants, municipal and industrial waste plants, others. Line drawings and photos illustrate design features and point out advantages. Recommendations for selection of frames and other equipment, as well as specifications, and clearance dimensions are given. Rodney Hunt Machine Co.

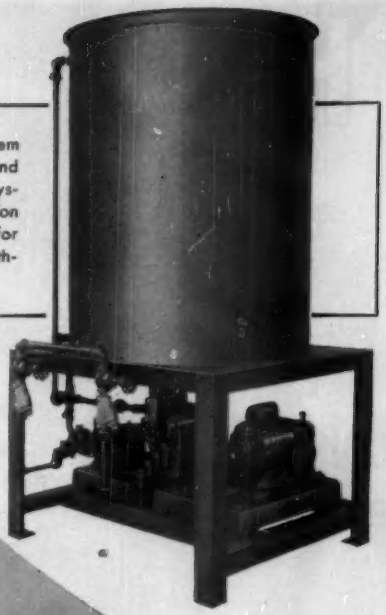
156 Cooling Tower Test — CTI Bulletin ATP-105 details the acceptance test procedure for water-cooling towers of the mechanical draft, industrial type. Explains scope and purpose of test, conditions of test, instruments and measurements, evaluation of results, report of results. Cooling Tower Institute.

157 Asbestos Sheet Packing — Compressed asbestos sheet packing is described in this bulletin, which includes specifications and uses of 11 grades. Covers high grade sheets for severe conditions; synthetic bonded types, neoprene and Hycar, where oil and solvents are involved; competitive qualities for general purpose and where price is factor. Industrial Products Div., The B. F. Goodrich Co.

158 Tractor Shovel — Engineering, design and production stories on company's HD-11G tractor shovel are pictorially presented in 8-pp Catalog MS-460. Includes specifications and describes features which mean easier servicing for less down-time in the field, greater operator comfort and increased productivity. Allis-Chalmers Mfg. Co.

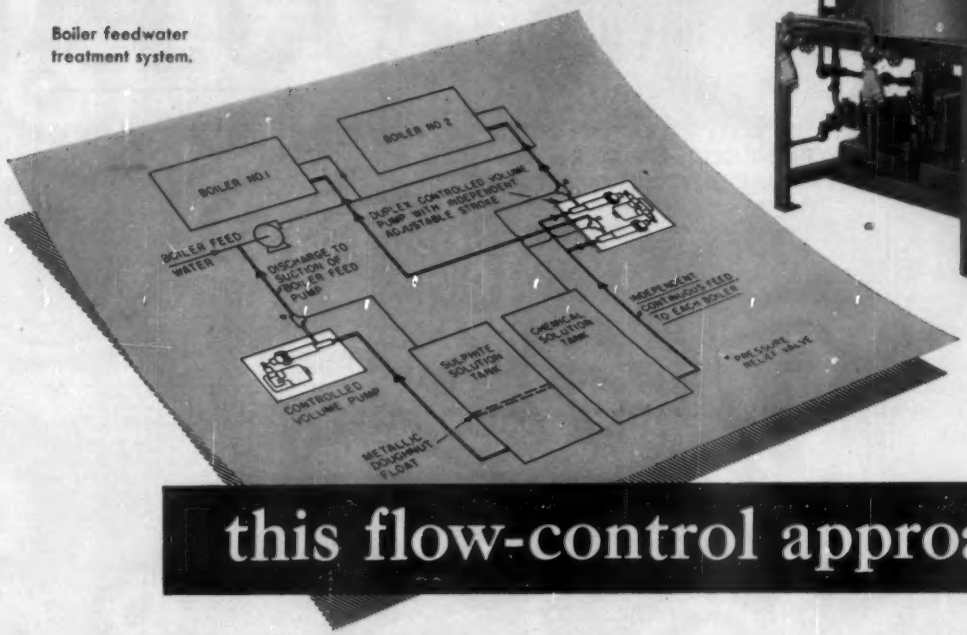
159 Vibration Control — Bulletin F2A shows how to write complete, correct vibration control specifications for all types of air conditioning and related equipment. Contains a definitive treatment of factors involved in selection of various isolation media, with particular attention to the influence of existing job conditions. A selector chart is also included. The Korfund Co., Inc.

160 Industrial Ventilation — Bulletin 6514 describes company's Model K ventura fans for industrial heavy-duty exhaust applications. Outlines construction features and explains their significance. Performance data such as delivery ratings at various static pressures, fan speed, mo-



Typical Milton Roy packaged system —comprising a chemical tank and two Controlled Volume Pumps. Systems supplied with chemical solution tanks up to 500 gal. capacity . . . for any boiler pressure . . . with or without automatic control.

Boiler feedwater treatment system.


BOILER NO. 1
BOILER NO. 2
DUPLEX CONTROLLED VOLUME PUMP WITH INDEPENDENT ADJUSTABLE STROKE
BOILER FEED WATER
DISCHARGE TO SUCTION OF BOILER FEED PUMP
INDEPENDENT CONTINUOUS FEED TO EACH BOILER
CHEMICAL SOLUTION TANK
SULFITE SOLUTION TANK
CONTROLLED VOLUME PUMP
METALLIC-DONUT FLOAT

this flow-control approach

cuts cost of boiler water treatment . . . boosts boiler and turbine life

REDUCED chemical costs, increased boiler and turbine life . . . result when treating chemicals are *accurately* metered in boiler water treating systems.

This simple packaged system, for example, provides an economical solution to the continuous treatment of boiler feed water. A simplex Controlled Volume Pump injects sodium sulfite directly into the reservoir of the deaerating heater, thereby removing residual oxygen and preventing pitting of economizers and boiler feed pumps. A duplex Controlled Volume Pump meters phosphate directly to the boiler drum of each of two boilers, thereby removing dissolved minerals and preventing scale formation in boiler tubes.

Milton Roy engineers and fabricates complete packaged systems for the treatment of boiler feedwater, with all necessary piping, valves, and liquid level gauge. Agitators, dissolving baskets, instrumentation, and alarms can also be furnished, as desired.

How can we serve you?

Write for technical information. Or, send your problem to Milton Roy Company, *Manufacturing Engineers*, 1300 East Mermaid Lane, Philadelphia 18, Pa.

Engineering representatives in the United States, Canada, Mexico, Europe, Asia, South America, and Africa.

milton Roy
CONTROLLED VOLUME PUMPS

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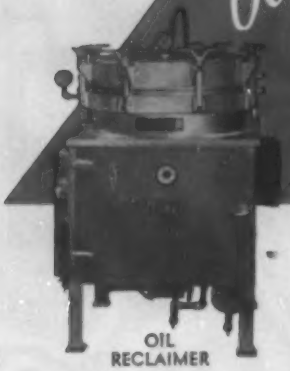
HILCO OIL RECLAIMERS

REMOVE WATER, SLUDGE, ACID

for complete

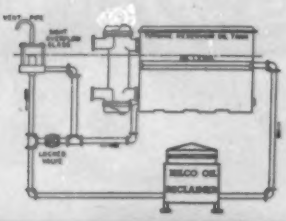
TURBINE OIL CONDITIONING...

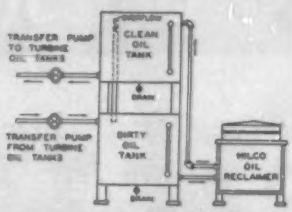


OIL RECLAIMER

The HILCO Turbine Oil Reclaimer is a self-contained, compact unit that will produce and maintain oil free of all solids, sludge, acids, moisture and air, keeping the oil in first class condition. Its purifying process is a continuous, all electric, automatic operation, requiring infrequent attention. It removes contaminants as fast as they are formed, maintaining lubricating oil at full value of new oil. HILCO Oil Reclaimers will also purify compressor, hydraulic, insulating, Diesel and gas engine lube oils.

Purifies Turbine Oil by Continuous or Batch Purification . . .





A continuous, direct-connected, foolproof oil reclaiming system. Oil flows from turbine reservoir first to sight overflow glass, to HILCO Oil Reclaimer, and back to reservoir.

A batch system designed to serve one or more turbines when it is desired to withdraw all the oil from reservoir for complete periodic batch reclaiming to restore all oil as good as new.

WRITE FOR THIS FREE BOOKLET TODAY . . .

FOR MORE INFORMATION ON HILCO TURBINE OIL RECLAIMERS . . .

THE HILLIARD Corporation

162 W. FOURTH STREET ELMIRA, N. Y.

IN CANADA: Upton-Bradeen-James Ltd., 890 Yonge St., Toronto; 3464 Park Ave., Montreal

For more data circle 523 on Post Card

tor horsepower, quietness rating and maximum net weight are given for 45 units. American Blower Corp.

161 Anti-Corrosive Water Treatment — Catalog Sheet CS-101 discusses problem of preventing corrosion of drinking water lines. Details a new service which is designed to stop "red water troubles" and prevent destruction of piping. The Permutit Co.

162 Hydraulic, Air Components — Well organized, and clearly illustrated, 36-pp Catalog 555 describes both products and services offered by this company. Gives special features, specifications and applications of a line of pumps, cylinders, jacks, braces, other units. Also pictures some specially designed equipment. Star Jack Co., Inc.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the Reader Service Cards, page 117. When ordering catalogs, allow time for us to relay your requests to the manufacturers—and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

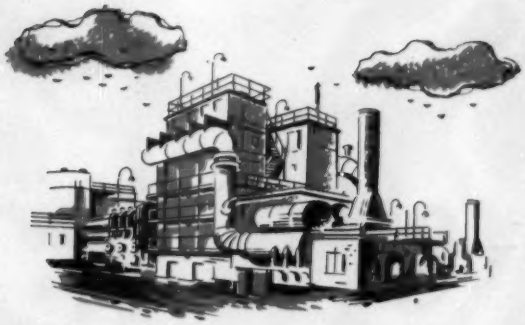
163 On Tube Corrosion — Eleven ways to avoid boiler tube corrosion are outlined in 8-pp Bulletin TR-537. Explains causes of corrosion in boiler tubes and suggests methods of eliminating these causes. Tubular Products Div., The Babcock & Wilcox Co.

164 Submerged Combustion — Bulletin 110 describes the application of high velocity burners to submerged combustion techniques as one of the most effective methods for heating a liquid. Construction features are described and advantages pointed out. Dimensions and specifications are listed, as well as possible applications. Thermal Research & Engineering Corp.

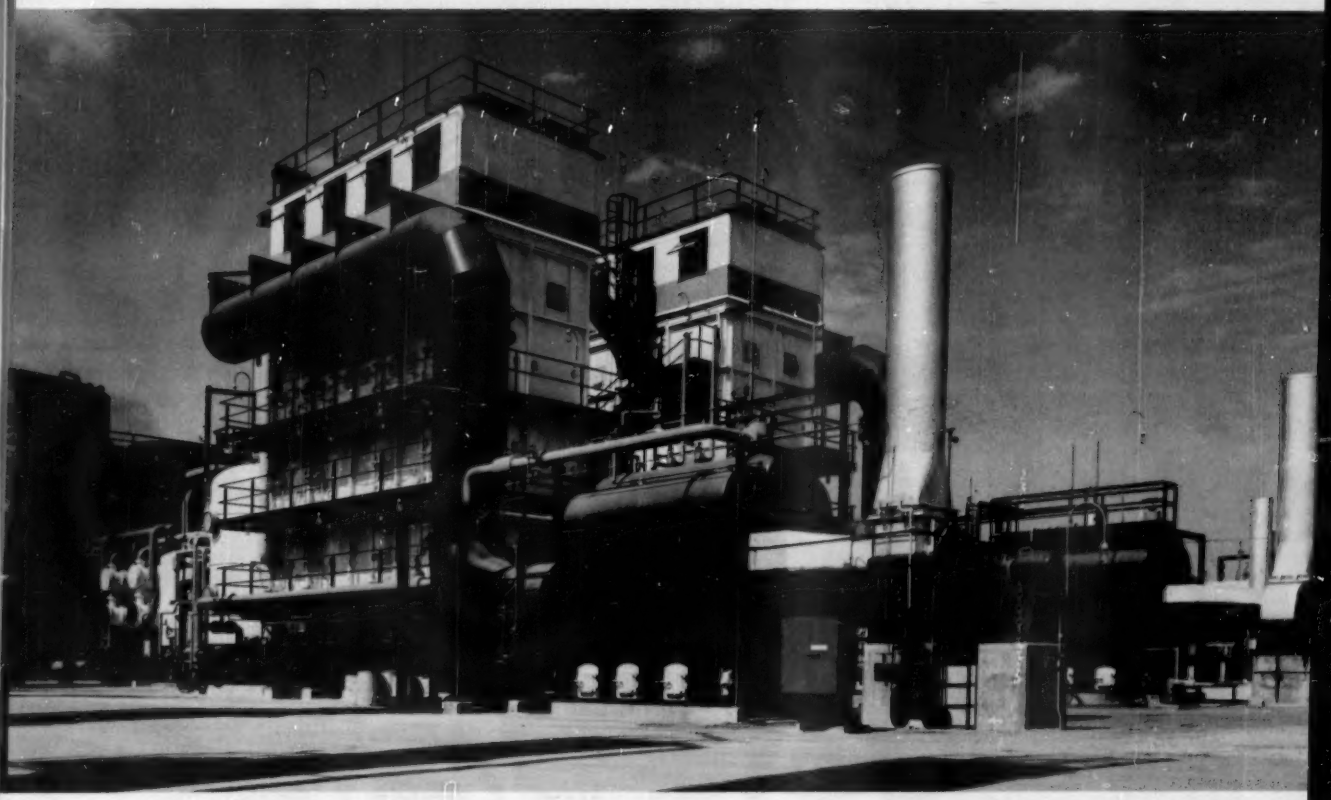
165 Door Heaters — Bulletin DH-2, 8-pp, contains a selection chart by means of which the proper size heater can be selected for a given size door and a given set of temperature conditions. Dimensions, capacities and methods of control are also included. L. J. Wing Mfg. Co.

166 Dehydrator-Filter — Bulletin M-7155 features a moisture-vapor content chart which enables evaluation of the water vapor in a compressed air system. Describes company's M-series Condensi-filters for dehydration and filtration of compressed air. Hankison Corp.

167 Storage Tank Venting — Principles of venting flammable liquid storage and process tanks for effective operation, fire protection and low-cost maintenance are described in this 12-pp booklet. Defines principles as applied to non-conservation and conservation type venting. Flame arrester units for guarding storage tank fill openings, and rodding and sampling operations are also covered. Protective devices for fuel tanks of diesels and gasoline powered equipment, and protection in loading and unloading railroad cars and tank trucks treated. The Protectoseal Co.



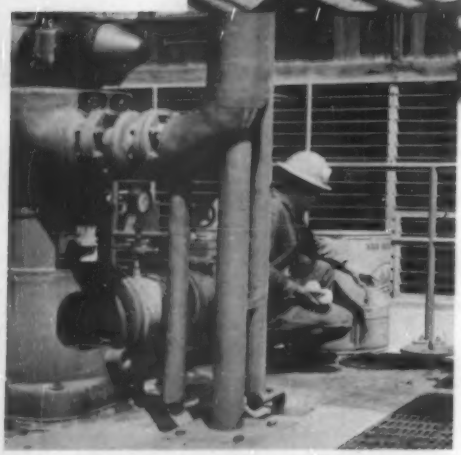
Water treatment by NALCO protects boilers and cooling system of a big new ammonia plant



Processing units (left) and Nalco-protected waste heat boilers in new $13 million Brea Chemicals, Inc. ammonia plant.

When $13,000,000 goes into a brand new ammonia plant . . . equipment, services and supplies must be right up to snuff from the start. The Nalco System has been working here from the beginning—and the Nalco treatments and services rendered in a successful plant-wide program point up the advantages to be gained with the Nalco System in plants new or old.

See the next page for details on Nalco results on Ammonia Road.

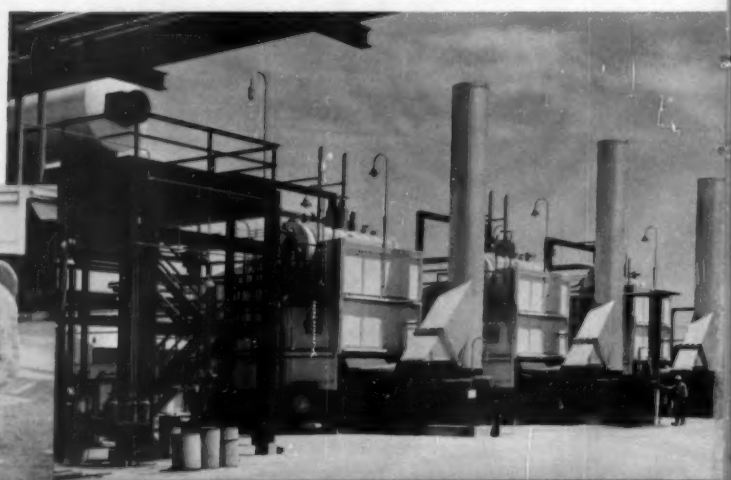


Top—Large cooling tower at this new west coast ammonia plant gets protection against scaling and corrosion with a non-toxic Nalco formula. Low pH treatment stops deterioration of cooling tower lumber and cuts dosage requirements for slime and algae control.

Above—Ball form cooling water treatment is merely dropped into a simple wire basket device suspended in cooling tower basin.

Nalco System treatments on Ammonia Road solve these important water and steam processing problems: scale and corrosion prevention in both water and steam systems; boiler-water foam control and sludge-conditioning; and contamination-free process steam.

Whatever your water treatment problems may be—in a plant of any size—there is a Nalco System program designed to solve them, permanently . . . and economically. Write or phone today for details.



Above—Three steam generators on outdoor settings provide super-pure steam for ammonia processing and heating. Nalco chemicals in ball-briquet form are put into by-pass feeders (left) to insure trouble-free water treatment on Ammonia Road.

NATIONAL ALUMINATE CORPORATION
Phone: Ottawa 9-7240
6216 West 66th Place
Chicago 38, Illinois

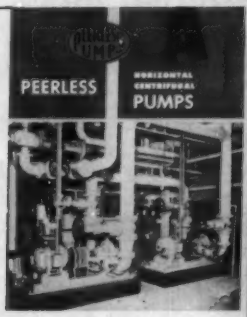
In Canada, Nalco (Canada) Limited
Burlington, Ontario

THE Nalco® SYSTEM . . . Serving Industry through Practical Applied Science

look AT THE PUMPING PROBLEM *two ways*

VERTICAL

HoRizontal



PEERLESS PUMP DESIGNS PROVIDE THE RIGHT TYPE FOR DOING THE JOB BETTER

You pick the design; Peerless will supply the pump. From one of the broadest range of pump capacities, heads, horsepowers, you can choose a Peerless horizontal or a Peerless vertical pump for almost every liquid transfer job, involving either water or process liquids.

In the picture at the top above, a concentrated solution of sulphuric acid and aluminum sulfate is being pumped by Peerless vertical industrial service pumps. To find out all about them request Peerless Bulletin No. B-505.

The Peerless horizontal type A pump shown just above, is one of three that supplies plant water for a textile mill. To find out all about them request Peerless Bulletin B-1300 and B-1350.

Use the coupon below to find how these Peerless designs can meet all your pumping needs with economy, efficiency and dependability.

PEERLESS PUMP

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PEERLESS PUMP DIVISION
FOOD MACHINERY AND CHEMICAL CORPORATION
Factories: Los Angeles 31, Calif., and Indianapolis 8, Ind.
Offices: New York; Atlanta; Chicago; St. Louis; Indianapolis, Ind.; Phoenix; Fresno; Los Angeles; Plainview and Lubbock, Texas; Albuquerque, New Mexico.
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Please send bulletins checked below:

- ☐ PEERLESS INDUSTRIAL SERVICE PUMPS (B-505)
- ☐ PEERLESS TYPE A HORIZONTAL PUMPS (B-1300)
- ☐ AND TYPE AS (B-1350)

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COMPANY_____

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CITY_____ STATE_____

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Are those all the ashes for the day?

That's all! We're using a low-ash coal now. The analysis shows only one-half as much ash as the coal we had been using, and there is a great deal less unconsumed coke on the refuse.

But don't we have to pay more for this kind of coal?

Yes, we may pay more at the mine, but it costs us less delivered. Remember we used to pay freight on all those ashes and then pay to haul them away. And because there is so much more usable coal in each ton, we use fewer tons.

Who showed us how to make this saving?

A C&O fuel service engineer gave us the facts and figures to show that this higher quality coal would really cost us less in the long run, and our experience has proved he was right. I am convinced now that you can't buy coal on price alone. It pays to get the advice of a competent combustion engineer and to pick the coal that will do the best job under your own set of conditions.

P.S.

There's a lot more to buying coal than the cost per ton. Why not contact coal producers on the C&O to solve your particular fuel requirements, or write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake and Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

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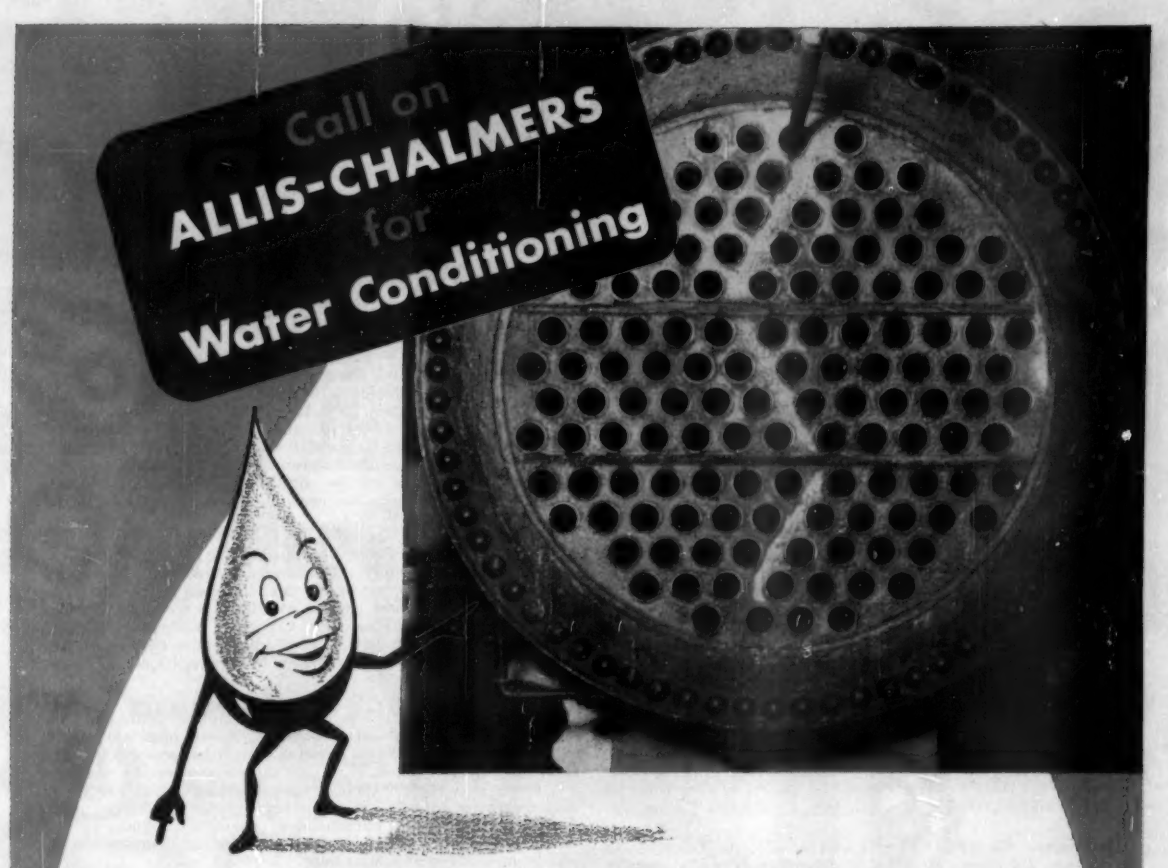

12 MONTHS OF CONDENSER OPERATION AND . . .

Absolutely No Scale or Corrosion

Always before, every year, a heavy maintenance job. Until this year, that was the story of the horizontal ammonia condensers at the 4th Street Plant of Terminal Refrigerating and Warehousing Corp., Washington, D. C. Now Allis-Chalmers chemical treatment has provided a new picture, shown above.

You can see for yourself — there are no signs of scale or corrosion. There are scars from cleanings after previous years' operation because it used to be routine to find fairly heavy deposits partially plugging most of the tubes.

After complete analysis of both incoming water and operating conditions, Allis-Chalmers water conditioning engineers provided a recommendation that resulted in a vastly reduced maintenance problem for the plant engineer. A-C engineers also advised on efficient means for introducing the necessary chemicals into the system.

For your own water problems, it will pay to take advantage of Allis-Chalmers experience. Get more information — or a specific consultation on your problems — by calling your nearby A-C office. Or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

A-4822

ALLIS-CHALMERS

WATER CONDITIONING—CHEMICALS, EQUIPMENT, SERVICE—FOR OVER 25 YEARS

A-C ALLIS-CHALMERS

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CONSTRUCTION NEWS

Gorgas, Alabama — Alabama Power Company, Birmingham, Alabama, has approved plans for the construction of its ninth steam electric generating unit at local site. Company's eighth generating unit is still under construction and when completed in 1956, as per schedule, will have an output of 156,250-kw. The proposed unit will have a capacity of 190,000-kw and is expected to be completed by late 1958, — making the total generating capacity at this station in excess of 736,250-kw. Cost of new unit estimated at $24,000,000.

Delaware City, Delaware — Delaware Power & Light Co., 600 Market St., Del., has approved plans to build, own and operate a new 50,000-kw steam generating and electric power station at site of new 130,000 barrel per day plant of Tidewater Associated Oil Co., 17 Battery Place, New York, N. Y., now under construction. Three boilers planned will produce 500,000 pounds of steam per hr at 1250 pounds per sq in. and 950 F., and will use fluid coke as fuel, produced at refinery's fluid cooking unit, the world's largest. Power plant will be equipped with two turbo-generators, each with a capacity of 25,000-kw. Cost of project estimated in excess of $18,000,000. A third generator and boiler are being planned for the future.

Ft. Lauderdale, Florida — Florida Power & Light Co., Miami, Fla., has awarded construction contracts and preliminary work is under way on the installation of two 160,000-kw turbine generators at company's Lauderdale plant. The installation of these units, the largest in the state to date, will add one and one-half more generating capacity to local plant than its entire system's production in 1955. The first generator is scheduled to be put in service in 1957 with the second installation following about a year later. Plant will be company's largest power producer with a total of 414,000-kw when completed and a system total at that time of 1,282,000-kw.

Tavernier, Florida — Florida Keys Electric Cooperative Association, Inc., has authorized plans and work will get under way soon on new power substation and transmission lines between Florida City and Tavernier, Fla. Cost of this project is reputed to be in excess of $1,025,000 and is scheduled for completion late in 1956.

Chicago, Ill. — Commonwealth Edison Co., 72 West Adams St., Chicago, Ill., has foundation under way for new proposed Hanson Park power substation at 5113 W. Grand Ave., Chicago. Contract includes concrete foundation, general yard work, pipe installation, etc. Paschen Construction Co., 2739 N. Elston Ave., Chicago, Ill., General Contractors.

New Albany, Indiana — Public Service Co. of Indiana, 1000 E. Main St., Plainfield, Ind., plans new steam electric generating plant, with initial capacity of 300,000-kw. Site is being cleared and work is under way. Plant will be completed in 1958 at a reported cost of $45,000,000, with power substations, transmission lines and other operating facilities.

Baltimore, Md. — Baltimore Gas & Electric Company, Lexington Bldg., Baltimore, Md., has plans under way for new Uplands Electric substation. Building will be steel structure with two smaller brick buildings for operational facilities. A four and one half mile pipe line is also planned from company's power plant in Westport. Cost of project reported to be $4,600,000.

Kissick, Mo. — City Utilities of Springfield, Mo., has plans under consideration for the construction of a new steam electric generating station on the James River near Kissick, Mo. Initial capacity of unit will be 44,000-kw. No estimate of cost announced. Burns & McDonnell Engineering Co., Kansas City, Mo., Engineering Consultants.

Deepwater, N. J. — Atlantic City Electric Co., Kentucky & Pacific Avenues, Atlantic City, N. J., has approved plans for expansion at utility's Deepwater generating station, near Penns Grove, N. J., with addition of a 75,000-kw. turbo-generating unit. Deepwater extension is part of company's expansion program for expected growth in southern New Jersey and will raise capacity to a total of 403,500-kw. Cost of new installation expected to exceed $11,000,000 and is scheduled for completion in early 1958.

Newark, New Jersey — Public Service Electric & Gas Co., has arranged for sale of a bond issue to total $35,000,000 and a preferred stock issue of $25,000,000 to finance contemplated construction program expected to reach $166,000,000, of which $37,500,000 will be used for expansion and improvement in company's electric facilities.

Rayland, Ohio — Cleveland Electric Illuminating Co., Illuminating Bldg., Cleveland, O., announced the purchase of a 100 acre tract of land for possible site of future power plant, on the Ohio River, midway between Steubenville, Ohio and Wheeling, West Virginia. The site, large enough for 1,000,000-kw capacity generating unit, is near the village of Rayland, O. Plans for construction will be announced later and if built in the near future will be joined with company's present system by means of high-voltage transmission lines.

Portland, Oregon — Portland General Electric Co., Southwest Alder St., Portland, Oregon, has plans under way for proposed hydro-electric project to develop 75,000-kw on the Clackamas River, approximately 30 miles east of this city. Installation calls for two generators with a combined capacity of 50,000-kw at North Clackamas site along with construction of a 620 ft dam. The Cazadero dam would be improved, to up the capacity of the Faraday Power Plant by an additional 25,000-kw. Company expects to get work under way early in 1956 for completion in the spring of 1958.

Allentown, Pa. — Pennsylvania Power & Light Co., Ninth & Hamilton Streets, Allentown, Pa., has approved plans to step up construction budget to cover the next five year period by 20%. Company plans to boost capital spending up to $1,200,000 per week through and including 1958. Company is presently engaged in expansion and improvement program of entire system, including power substations, transmission lines, operational facilities, etc.

Memphis, Tenn. — The city of Memphis, Tennessee, has announced through Major Thomas H. Allen, president of the city's Light, Gas and Water Division, that it has appointed Burns & Roe, Inc., New York, N. Y., to do the engineering work for city's proposed $100,000,000 steam generating plant. The firm's responsibilities are to select and secure suitable site for the plant, designing of the plant, purchasing of machinery, signing of contracts and general supervision of construction. Further details will be announced at a later date.

Garland, Texas — City of Garland, Texas, has announced the award of contract to Elliott Company, Jeanette, Pa., for the installation of two electric generator units at local plant. Cost reported to be approximately $625,000.

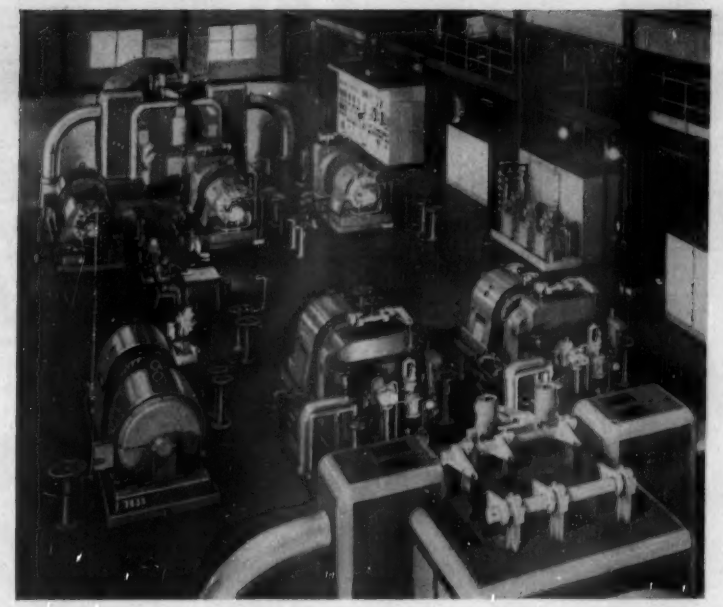
Salt Lake City, Utah — Utah Power & Light Co., Kearns Building, Salt Lake City, has disposed of a bond issue totalling $15,000,000, proceeds of which to be used in connection with company's expansion program and improvements in company facilities, — such as generating stations, power substations, transmission lines and other operating facilities.

Leesburg, Virginia — Potomac Electric Power Co., 10th & E Streets, Washington, D. C., has approved plans to build a new $70,000,000 steam electric generating station on 500 acre site acquired for the purpose in Loudoun County on the Potomac River. Initial building will house two 150,000-kw turbine generators and related auxiliaries. First unit is scheduled to be in operation by spring 1958 and the second in the spring of 1959. Preliminary installation expected to cost about $25,000,000 and final development to include four turbine generators with total capacity of 600,000-kw output, ultimately to represent total expenditure of $70,000,000.

Yorktown, Virginia — Virginia Electric & Power Co., Richmond, Va., has authorized plans for the erection of a $20,000,000 electric generating station on the York River, about six miles east of Yorktown, Va. The plant will have an initial capacity of 165,000-kw and is said to be the first power plant designed specifically to burn refinery coke. Boiler installation will be able to fire all three fuels at the same time or operate entirely on coal. The installation will be designed and constructed by the Stone & Webster Engineering Corp.

Cassville, Wisconsin — Wisconsin Power & Light Co., 122 W. Washington Avenue, Madison, Wis., has foundations under way for proposed new steam electric generating plant, north of Cassville, Wis., on the Mississippi River. Initial expenditure reported to be approximately $20,000,000. Details of plant's size and capacity will be announced in these columns at a later date. Sargent & Lundy, 140 S. Dearborn St., Chicago, Ill., are the engineers.

What makes a barrel-type boiler feed pump *stay in service?*



Here are some of the design features that assure dependability

Today's modern multi-stage centrifugal pumps for boiler feed service are the result of years of research and design. To provide efficient service *plus* dependability, De Laval has incorporated these important features in its barrel-type pump.

Double Volute Diaphragms

Double volute diaphragms provide for radial hydraulic balance and assure a continuous rising head characteristic from the design point to shut-off. *RESULT—Higher efficiencies are maintained over a wider range of operation than are generally obtained with other forms of velocity pressure conversion.*

Individual Diaphragm Bolting

Elimination of rabbet fits and gaskets permits straight metal-to-metal contact of adjacent lapped faces of the diaphragms which are individually bolted together to maintain tight joints and ease of assembly. *RESULT—Positive assurance against inner case leakage, complete elimination of misalignment causes and a minimum of distortion from sudden temperature changes.*

Positive Sealing Between Suction and Discharge Chamber

Inner assembly is held at the inner high pressure joint at the suction end of the barrel, against a flexitallic gasket, with through bolts. The joint between the suction and discharge chambers is made tight during assembly—remains tight whether pump is operating or idle. *RESULT—No possibility of leakage or gasket loosening due to changes of force on the inner joint.*

Bare Shaft

Bare shaft construction with split ring-shrink fit method of impeller mounting permits a scalloped shaft design and eliminates the need for spacer sleeves between impellers. *RESULT—Better hydraulic conditions at the eye of the impeller and elimination of spacer sleeves—the greatest cause of shaft warpage.*

Wearing Rings

Diaphragms and impellers have renewable wearing rings. Impeller rings are threaded on the impeller hubs against rotation, and diaphragm rings are held by a breech lock fit in the diaphragms. *RESULT—Construction permits renewal of original clearances without major part renewal or modification. Labyrinth type diaphragm ring results in minimum leakage over a longer period of time than with close clearance flat rings.*

IMO Oil Pump

A De Laval IMO pump designed for high speed operation is direct-connected to the outboard end of the barrel pump shaft, and is sized to lubricate both pump and driver bearings. *RESULT—Quiet, pulsation-free, positive displacement IMO pumps, assures positive lubrication and eliminates the need of extra shaft length and mechanical complications required by gear drive lube oil pumps.*

BULLETIN CONTAINS HELPFUL DATA

This De Laval bulletin on the barrel-type boiler feed pump covers all major design points . . . has cross-section cut-away illustration for easy reference. Write on your business letterhead for your copy of Bulletin 1506 to De Laval Steam Turbine Company, 816 Nottingham Way, Trenton 2, New Jersey.

For more data circle 528 on Post Card

EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 117–118 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—SOLENOID VALVE, full port, needs no back pressure

According to manufacturer, this full port, normally closed valve does not require back pressure in its operation — and it will operate and hold fully open with low or no flow pressure. Called the Type G, it is a packless solenoid valve having globe bronze valve body with screwed ends in sizes 1 to 3 in. with single seat full size valve port. A renewable resilient valve disc mounted in a bronze holder extends into an auxiliary piston and the pilot valve also has a resilient disc.

The valve is designed to open when coil is energized and close upon current interruption. A spring snaps it into closed position as soon as the coil is de-energized. Depending on application, Type G Valves may be controlled by thermostat, high or low limit switch, time clock or liquid level controls and other circuit breakers. Magnatrol Valve Corp.

2—DROPOUT CUTOUT with high interrupting rating

Having a 4000 amp interrupting rating, this 15 kv, 100 amp heavy duty dropout cutout is announced for applications where heavy duty interrupting ability is required. The unit is available with a load break device for opening circuits under load. This new rating contains all the features of company's open dropout cutouts, including birdproof construction, silver plated contacts, compression clamped hanger supports and fittings, and shielded top contact and latch. General Electric Co.

3—DISTRIBUTION BLOCK cuts wiring time

Tipco Distribution Blocks are designed to simplify wiring of panelboards and switchgear, cutting both wiring time and cost. They are available with either

2, 4, 6, 8, or 10 taps, each tap numbered for easy identification. Blocks are rated at 600 v for either 70, 125 or 225 amp service. Underwriter-approved pressure connectors allow multiple connections, in a wide range of wire sizes, to be made in one tap, it is pointed out, and vibration is not transmitted through the connector. When wired, block offers protection from live power, says company; the blocks eliminate bending and soldering leads, require no covers, special tools, or extra parts. Data Sheet 4-D-4 gives more details. Thayer Industrial Products Co.

4—PATCHING MATERIAL can be applied over wet floors

Unusual resistance to oil, grease, acids, and alkalis, even blood, is claimed for 45 Patch, and it can be applied over wet floors. The material comes in powder form and is mixed with water at time of application. Due to quick setting powders used in the mixture, maximum setting time is 4 hr, says company, and floors can be put back into service within 24 hr. 45 Patch is said to form a permanent bond with existing floor area and to last as long as the floor itself. Other advantages announced for 45 Patch are: it can be painted over; it can be used inside or out; it won't chip or crack once it sets. Colonial Refining & Chemical Co.

5—BREATHER VALVE for use on power transformers

Circle Seal P-391 Transformer Breather Valve is designed to meet applicable ASA requirements for control of temperature induced pressure changes in oil filled power transformers. Made of solid brass bar stock, the unit is claimed rugged in both construction and design and suited for mounting externally without additional protection. A standard gage connection is used and no additional piping required. Essentially two relief valves in a unit package, the valve also incorporates a manually operated sampling valve with hose barb connection, screened inlet and outlet. James-Pond-Clark.

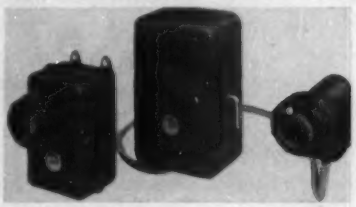
6—INSULATION RESIN now comes in improved form

Improvements are announced for both the resin itself and the packaging of Scotchcast Insulation Resin No. 4. In addition, three sizes on the package are now available — an economy advantage since the resin in the container is intended for use immediately after mixing. This epoxy-type resin in its self-mixing Unipak container permits making of "factory perfect" splices in power and communications cable under field conditions, says manufacturer. The splice is embedded in liquid resin which hardens quickly without application of heat, to form a permanent, moisture-resistant jacket.

Unlike the former container (which consisted of two packages, one inside the other) the new Unipak is a single package with a barrier strip sealed across the middle, separating resin and activator. Pulling on the sides of the container breaks the barrier strip and lets the resin and activator mix. As before, complete mixing is accomplished by kneading the container. Improvements in the resin provided are said to include greater durability, heat resistance, aging and "mixability." Electrical properties are also claimed improved. Minnesota Mining and Mfg. Co.

7—PHOTOELECTRIC CONTROL, for long-range operation

Set P4L Photoelectric Control System provides greatly increased operating distances, it is announced, plus high speed operation. It operates over distances up to 100 ft and affords speeds to 600 operations per minute. Major industrial

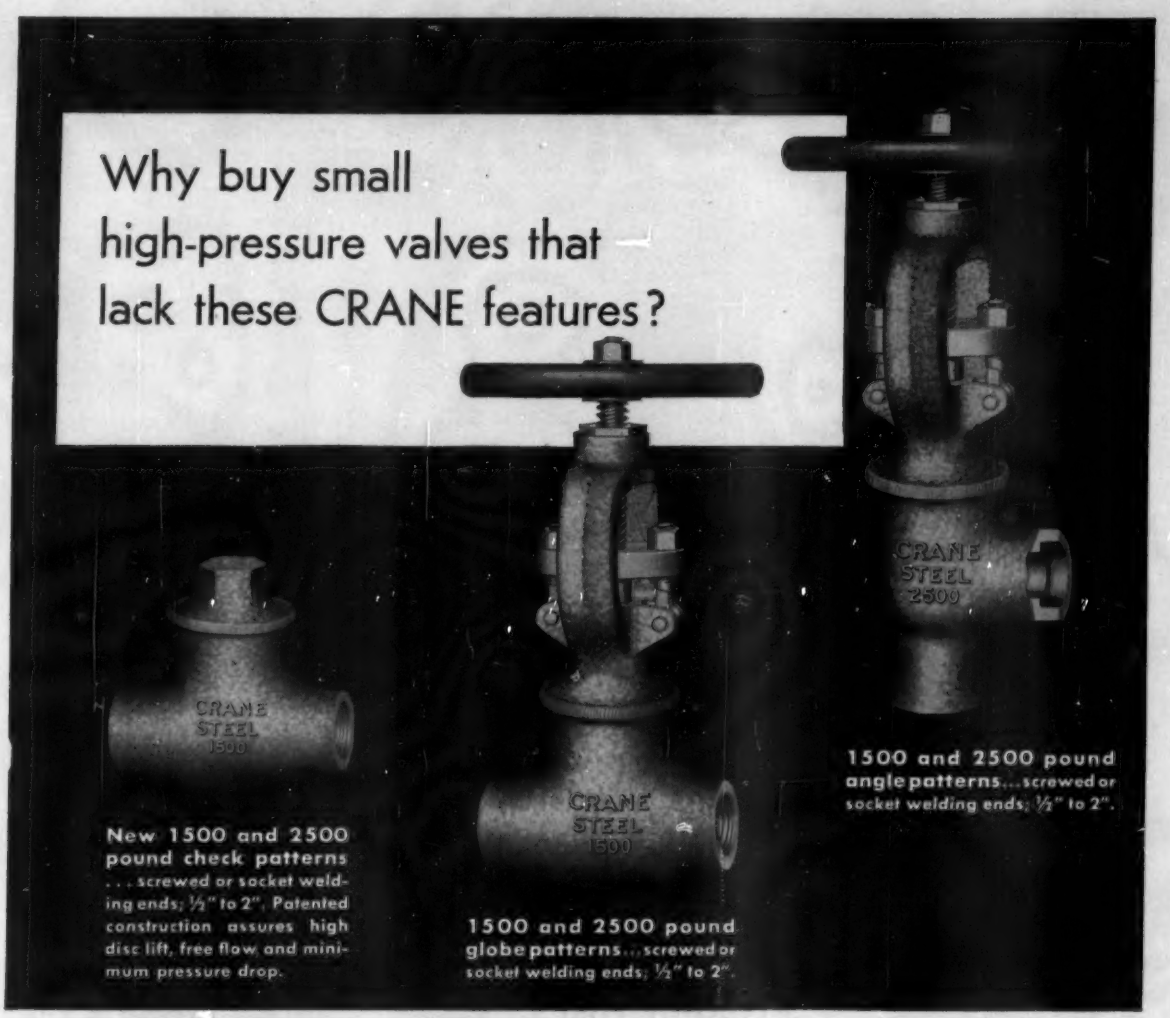


applications include: materials handling control over long distances, use with mirrors to provide "curtain of light" protection of large work spaces, operation of factory doors, and invisible beam system for intrusion alarms. Long-range protection is provided for personnel working on presses, other machines. Long-range set has a remote phototube with an extended lens system. Its plug-in chassis provides simple installation. Relay is actuated on the completion of the beam. Photoswitch Div., Electronics Corp. of America.

8—SUB-SURFACE WASHER combats backwash difficulties

This backwash device is reported highly successful in demineralizers, zeolite softeners and filters experiencing excess fouling of beds. Many waters are not turbid enough to justify clarification, it is explained, yet they contain enough soluble solids to plug softeners and filters — and usual surface washing devices become inadequate. According to manufacturer of this sub-surface washer, physical fouling of ion exchange and filter beds can result from any of three causes: dense precipitates, sticky precipitates, and fibrous materials. In all three cases channeling and short circuiting result in the beds unless the obstructing solids are broken up and removed. Attempts to accomplish this by using excess backwash rates causes loss of

Why buy small high-pressure valves that lack these CRANE features?



New 1500 and 2500 pound check patterns . . . screwed or socket welding ends; ½" to 2". Patented construction assures high disc lift, free flow and minimum pressure drop.

1500 and 2500 pound globe patterns... screwed or socket welding ends; ½" to 2".

1500 and 2500 pound angle patterns... screwed or socket welding ends; ½" to 2".

When you buy CRANE Lip-Seal Bonnet Valves . . . designed exclusively for high pressure/high temperature power plant service . . . you are assured of:

- lip-seal welds that are laid on flat surfaces — needn't be chipped out or burned out;
- easy dismantling and reassembly — bonnet screws out after weld is *ground away* — makes inside of valves entirely accessible;
- bonnet threads are chrome plated to prevent galling or seizing;
- stems that do not bind or gall — because of CRANE's exclusive ball-joint glands;
- easy access to stuffing box — swing-type gland eye-bolts swing free of yoke area, can't be lost;
- a more rigid swivel disc-stem connection that minimizes vibration;
- each size valve is a separate design for proper proportion — another CRANE exclusive.

Specify "Crane Lip-Seal" when you want small valves for high pressure/high temperature steam service. For more reasons why you should do so, ask your CRANE representative for Circular AD 1902, or write direct. CRANE CO., General Offices: 836 S. Michigan Ave., Chicago 5, Ill. Branches and Wholesalers Serving All Industrial Areas.

CRANE CO.

VALVES • FITTINGS • PIPE
KITCHENS • PLUMBING • HEATING

CRANE'S FIRST CENTURY...1855-1955

For more data circle 529 on Post Card

ion exchange material as well, it is noted. But the sub-surface washer is claimed successful in breaking up these solids, preventing bed fouling and permitting effective backwashing at normal rates. Graver Water Conditioning Co.

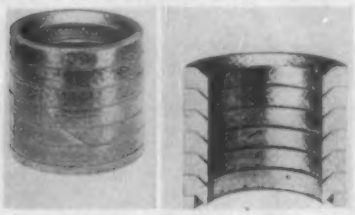
9—PRESSURE GAGE provides absolute readings

Prince Absolute Pressure Gage, Catalog 1470, is designed for turbine condensers, exhaust hoods, evaporators and other applications employing minus pressures. Gage is shipped ready to operate and is said to require no installation service other than mounting and connecting to line. Gages are individually calibrated by comparison with a high precision standard mercury column vacuum gage whose readings are corrected for prevailing barometric pressure.

Scale case and frame of this gage are of cast brass, with black crackle finish and lacquered brass trim. Frame is removable for cleaning or replacement of plate glass light. A condensation trap is included and is connected to mercury cistern by steel tubing. Gage components are mounted on a 22½ by 10½ in. hardboard, steel or aluminum plate. The instrument is available in four scale ranges: 18 to 30 in. (in 1/10 in. divisions); 0 to 12 in. absolute pressure; 0 to 6 psi absolute pressure; or 0 to 300 mm absolute pressure. Instruments can be furnished with electrical contacts for vacuum control or for alarm. Precision Thermometer and Instrument Co.

10—ASBESTOS PACKING for use in soot blowers

Cumpac Style 236 is announced as a special packing for soot blowers, made of high grade asbestos yarn braided over a plastic core of heat resistant composition, then lubricated with mica. Or, if desired, it may be graphite-lubricated. Design is a combination of lip style and solid packing arranged so that solid part takes gland pressure. This



leaves lips free to act upon pipe or tube. Actuated by fluid pressure, lips provide a tight seal with minimum friction. Company reports that packing withstands high pressure superheated steam without hardening, drying out or vulcanizing during exposure to heat and its sturdy construction lets it act as a bearing when needed. It is supplied in sizes to fit stuffing boxes of practically every soot blower. Johns-Manville.

11—TIME SWITCH, for heating, is weather actuated

For day-night or seven-day programming of heating systems, the Weather-Chron is actuated by the weather itself. According to manufacturer, the outdoor temperature automatically resets time the heating starts in the morning and time of cutback at night to provide comfort temperatures as needed. The Weather-Chron is designed to stop all heat input to the building when outdoor temperature rises above an adjustable pre-selected minimum. An added safety feature automatically eliminates the night setback when outdoor temperature drops below an adjustable pre-selected low level (as 10 F), it is noted. The seven-day programming feature adjusts hours of heating in accordance with needs of actual plant occupancy, individually for each day of the week. The Automatic Devices Co., Inc.

12—STEEL VALVE is quick-opening type

Designed for general industrial usage, this quick opening valve is announced for service at 600 psi at 800 F and 1200

psi at 100 F. Valve is recommended for use on steam, hot water, air, and gases. Streamlined design of valve permits maximum flow, company points out, and construction assures fast, positive openings and closures at pressures to 1200 W.O.G. Available sizes on request. The Klinger Corp. of America.

13—SAFETY PANEL for heavy loads on power line

Designed for excessive loads on a power line without blowing fuses, the Safety Power Panel's purpose is to facilitate use of motors, drills and auxiliary lighting through a multiple outlet circuit breaker. There are three models, with two or three circuit outlets, together with safety control toggle switches for operating motors. Circuits are protected by a 6-amp fuse for small power tools and a 10-amp delay fuse for up to ¾ hp a-c motor use. Goodwill Mfg. Co.

14—15-HP GENERATOR, force recirculation, balanced feed

Adaptation of balanced feed to this 15 hp unit is claimed to be the first successful application to a steam generator of the automatic, forced circulation type. Balanced feed means that as the generator is operating, cold water entering the system from the supply source is never admitted directly to the coils. Instead, as steam is taken off and the hot water in the accumulator drops to a fixed level, an automatic control admits unheated feedwater into the accumulator. The temperature of the feedwater is abruptly increased. At the same time, the feedwater is subjected to thermal shock, which encourages precipitation of solids. Thus, it is explained, water entering the coils is pre-heated and simultaneously freed of much of its mineral content.

This generator also has an automatic blow-down feature. It is suggested for use where low cost steam in smaller volume is required. Thermostatically controlled, it is designed to produce steam as steam is used. Four models are available. Clayton Mfg. Co.

15—CORDS, CABLES feature increased use of Neoprene

Portable electrical cords and cables in the Bronco 66 Certified line have an outer protecting jacket containing more than 67 per cent new Neoprene, says manufacturer. The increased Neoprene content in the jacket compound is claimed to give greater protection against factors which tend to attack portable power cables — oil, sunlight, ozone, abrasion, flame, acids, solvents, heat, abrasion and crushing. The new cords and cables are vulcanized by a process designed to produce a smooth jacket and impart flexibility. Jackets are branded every 2 ft. Vulcanized into the outer jacket are product name, type, number of conductors, rated voltage, other information. Many types are offered. The Western Insulated Wire Co.

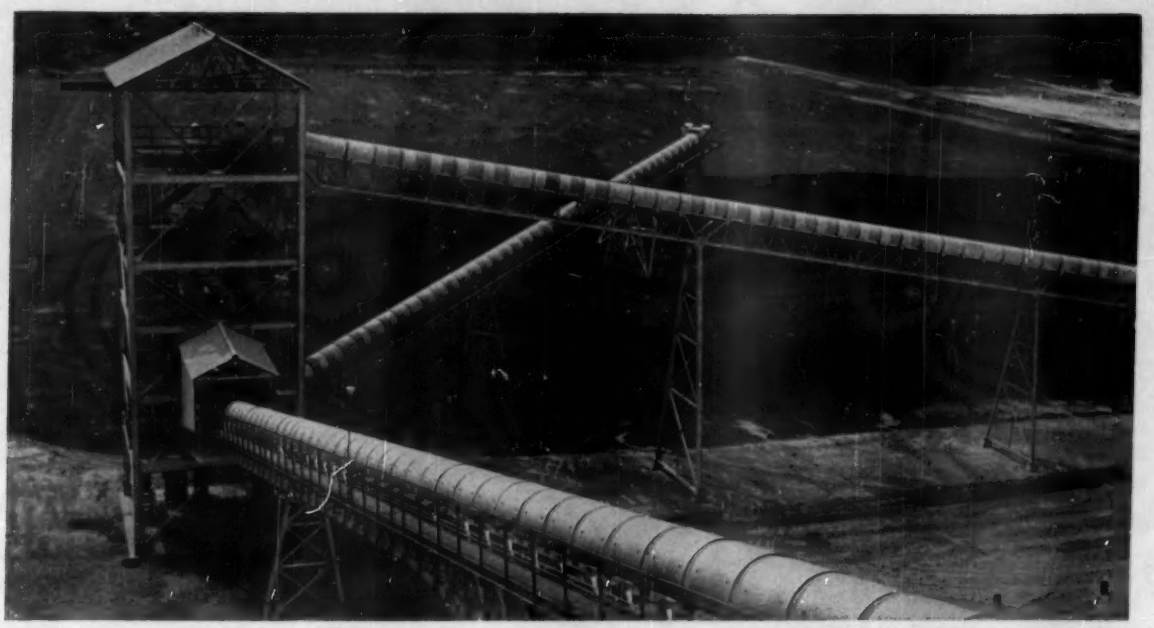
16—POWER PIPE SAW is large capacity tool

Big Guillotine cuts cast iron on steel pipe up to 16-in. diam on the job in minutes, it is claimed. This saw is designed to cut 10-, 12-, 14- and 16-in.

cast iron and steel pipe in a space only 32 in. wide. A double chain pipe vise clamps the saw to pipe. Machine cast steel V saddle base serves to assure a square cut at right angle to pipe. And the pipe acts as machine tool base. The Big Guillotine is a companion to manufacturer's Regular Guillotine for cutting 2- to 8-in. cast iron and steel and bar stock. The E. H. Wachs Co.

17—IMPELLER PUMPS for low pressure applications

These Neoprene rubber impeller pumps from ⅜ to 1¼ in. ips (iron pipe size) with flow ranges to 55 gpm are reported to combine the best features of the gear and centrifugal types. They are intended for use where a low pressure, low cost pump is required to transfer any liquid that does not affect bronze or Neoprene, with pressure range to 30



Coal Conveying - - - 26 Carloads Per Day

Louis V. Sutton Steam Electric Generating Plant • Carolina Power and Light Company

Temporary interruption of the flow of incoming coal can't interfere with power production at this plant . . . even though it consumes 26 carloads a day. An S-A Conveying System that keeps bunkers full and develops a million-dollar stockpile makes sure of that.

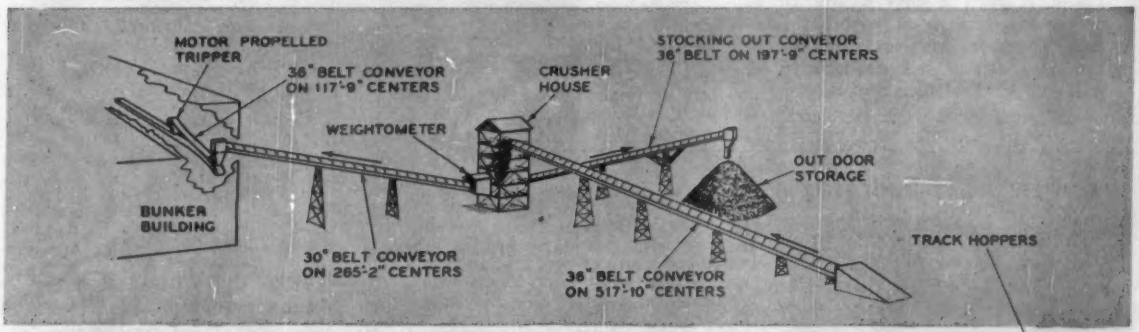
Coal arriving by rail cars is dumped into the track hopper. An S-A slope belt conveyor takes it, 450 TPH, to the "open air" crusher house. The coal is reduced to minus ¾" size in an S-A Knittel crusher that can't clog and that delivers *full capacity* even when handling wet, sodden coal.

From the crusher house, coal goes either to the stocking out conveyor or to the plant. At the storage bunkers a traveling tripper discharges through a "Zipper" bunker seal. This seal opens and closes like a slide fastener through bunker openings directly under tripper spouts, so that no dust can escape.

Coal to be stockpiled travels by a stocking out conveyor and is discharged through a telescoping spout that automatically shuts off flow when the pile reaches a predetermined height. Coal to be reclaimed is returned to track hopper by bulldozer or carry-all.

Corrugated steel hoods over all outside conveyors, and dust curtains at discharge points, effectively keep down dust. For all belts rugged, durable S-A "Simplex" carriers with spun ends and bearings protected by labyrinth seals were specified.

This is an example of the way S-A engineering can meet specific requirements for distribution, volume and clean handling. No matter how specialized your need, you'll find S-A experience and *complete equipment* offer a sound economical solution. Write us whenever we can help you.



SINCE 1901 S-A STEPHENS-ADAMSON MFG. CO.

STEPHENS-ADAMSON MFG. CO.

86 Ridgeway Avenue, Aurora, Illinois • Los Angeles, Calif. • Belleville, Ontario

Engineering Division
Specialists in the design and development of all types of bulk materials conveying systems.

Standard Products Division
A complete line of conveyor accessories including centrifugal loaders—car pullers—bin level controls—etc.

Sealmaster Division
A complete line of industrial ball bearing units available in both standard and special housings.

For more data circle 530 on Post Card

psi, depending on model. Pumps operate quietly in either direction at low or high speeds, company says.

These pumps can be used for refrigeration, for coolants, and wherever small pumps at a low pressure output are necessary. Impeller is replaceable at low cost and keyed to shaft for easy application. Pump itself is made of bearing bronze; shaft is stainless steel. It is designed to pass small particles of foreign matter and abrasives without jamming. Unit is self-priming to about 15–20 ft when wet and should operate at lowest speed commensurate with good delivery. Speeds range from 100 to 1750 rpm. Pumps are supplied to operate with high starting torque from ⅛ hp up. American Machine Products, Inc.

18—SWITCH provides timed pre-purge low-draft shutdown

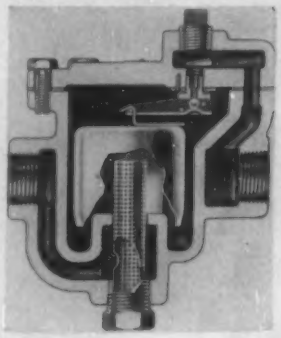
For automatic fuel-burning systems with motorized draft inducers, the Model LD2T-A Lo-Draft Cutoff Switch acts to provide a timed pre-purge period and protection against draft failure — without shutdowns due to momentary puffs during startup, or other transient conditions. It is designed to add protection from draft failure hazards to any boiler-burner installation, without complicated changes in the original wiring of burner and control circuit. It can also be used when pre-purge is already provided by existing burner controls.

The switch is energized at the same time as the fan starter. After 20 sec, current flows to a draft safety switch. This, operated by a sensing mechanism connected to a breech draft sample, passes current to a time-delay tube, if draft conditions are safe. After 10 sec, the tube passes current to the burner starting device. If draft is not sufficient, burner cannot start and an indicator lamp lights. If draft fails, an 8-sec time delay begins — then if draft is not restored, burner is shut down. But momentary puffs do not cause burner to shut down or recycle, it is stated. Switch will operate on 115- or 230-v a-c. Cleveland Fuel Equipment Co.

Reader Service Cards on pages 117–118 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

20—BUCKET STEAM TRAP withstands loss of prime

The Type B1-X Inverted Bucket Steam Trap is claimed to be superior in retaining prime under difficult operating conditions: light loads, rapid pressure drops and partial vacuum in the return line



caused by night shut-downs. According to manufacturer, it is specifically designed to prevent the possible loss of prime with consequent blow-through of steam, (an inherent weakness in inverted bucket steam traps), and this has been accomplished without reducing capacity or operating pressure range.

High discharge capacity and quick action announced for this and other models of company's inverted bucket traps are made possible by use of large valves operated by the Camlift valve mechanism. This mechanism is designed to provide the force needed to open the large valves against the steam pressure without making the traps bulky — and also to assure quick opening to prevent waterlogging of unit being drained. Bulletin 360-A gives data. Sarco Co., Inc.

21—CONTROL VALVE for hazardous process flows

The Bantam Bellows Sealed Diaphragm Control Valve is announced for leak-proof control of hazardous process flows. Assembly 2038, utilizes a special flange facing to receive ½ in. 150 lb, ASA raised face flange, action air-to-close, Teflon seating, with extra Teflon packing above bellows. Stainless steel material is used in body and bonnet assembly. Any available barstock material may be used. Maximum diaphragm pressure rating is 100 psig. Bellows rating is 500 psig at from −70 to 700 F. The George W. Dahl Co., Inc.

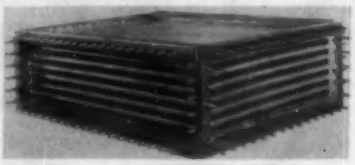
22—GLOBE VALVE for liquid immersed transformers

Catalog 121 Valve comes in ¾-, 1-, 1½-2-in. sizes, rated for 150 lb maximum pressure at 200 F maximum temperature. It has a screwed bonnet, integral semi-crown seat, spun-on connection between stem and disc holder and a synthetic-base composition disc reported highly efficient in transformer oil service. A boss on the outlet side can be tapped for insertion of a ¾-in. vent valve. For use with non-inflammable synthetic Askeral the new globe valve may be ordered with a special disc and packing.

Announced for use with this globe valve is a redesigned vent or sampling valve, No. 211. When installed at the top of liquid-immersed electrical equipment, the No. 211 can be used as an air vent. Installed at a low point, it is used to draw off samples of the liquid. The 211 Valve is made with a ¾-in. male pipe thread inlet and has a bibb on the outlet. Opening and closing is by means of a screw drive slot. Its disc is oil-resistant composition designed for use with either standard transformer oil or non-inflammable synthetic immersion liquids. Manufacturer recommends it for 400 lb maximum pressure, 200 F maximum temperature. Crane Co.

23—HEAT EXCHANGER for high temperature waste gas

Having a finned plate design developed for recovery of heat from high temperature waste gases, the G-R Plate-Fin Exchanger is designed to withstand gases at pressure to 100 psi and temperatures to 1100 F. Some of its applications are as a gas turbine regenerator, recovery of stack gas heat for preheating



furnace or kiln air, heating or cooling process gas or plant air, and other gas-to-gas services such as vapor-to-vapor exchangers in petroleum processes.

The exchanger is of compact, cross-flow design, with extended surface consisting of corrugations on both shell and tube sides. As shown, an individual cell consists essentially of three simple parts: corrugated sheets, formed and butt-welded flat tubes, and blanked and extruded sheet metal tube sheets. Sealing surfaces are heliac welded and all surfaces are covered with a protective nickel-base brazing alloy which also joins the corrugated sheets to the tubes. The Griscom-Russell Co.

24—LEVEL CONTROLLER combines electronics, pneumatics

The Pneutronic Level Control is announced as combining practical advantages of both electronic and air pressure control instruments. It utilizes the accuracy of electronic capacitance sensing elements to detect minute changes in levels in tanks, drums, process baths, pipelines and other conveyors. Electronic signals are then converted into proportional pneumatic output. This modulating air output, according to

19—MOTOR LOAD INDICATOR is styled for quick, and easy reading

The MEK-2127 motor load indicator is designed with easy-to-read scales calibrated in either per cent load or horsepower, with large color bands which enable operator to see at a glance how machine is performing. Conversion unit may be mounted near motor starter and light control wires can be connected to indicator. Such an indicator enables operator to obtain better tolerances and finishes, obtain maximum tool life, reduce tool breakage and damaging overloads. Dual voltage units are adjustable for operation on either 220 or 440-v systems. Special scales can be supplied for any type motor or load. Machinery Electrification, Inc.

the seal of quality in water tube boilers...

ESTABLISHED 1864

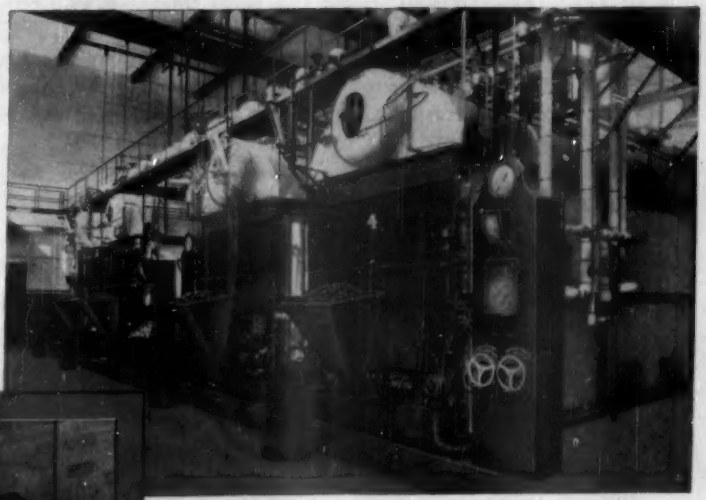
KEELER

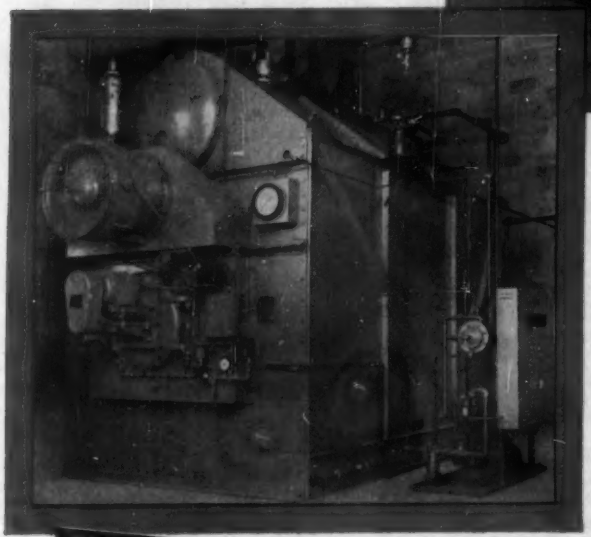
WATER TUBE

PACKAGE STEAM GENERATORS

Original of their type...Recognized Quality

Twenty years ago, the Keeler CP Steam Generator introduced what we know today as "Package Boilers", with the incorporation of furnace water wall design in a package unit for both large and small boiler users. Prior to 1935, this principle was uncommon except in large high pressure installations in utilities and larger industries. The CP became a pacesetter with its large power plant resources in package form by providing a reliable, efficient source of low cost steam for power, process and heat requirements in thousands of operations throughout the nation and abroad.





KEELER Type CP

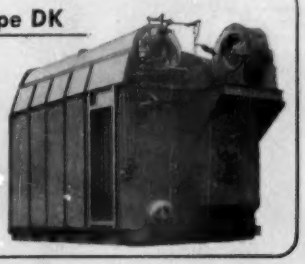
Original of the package steam generators, the CP delivers high efficiency with any method of firing (induced, natural or forced draft). Available for all types of fuel and readily convertible at minimum cost. Operates at high overloads without disturbing water level. More steam capacity in a given space and larger combustion chamber with less head room than any other type. Made in a wide range of sizes, in pressures to 500 psi with capacities to 150,000-lbs. of steam per hour.

KEELER Type CPM

A modification of the CP for gaseous fuels use. An economical forced draft, pressurized furnace unit complete with burning equipment and accessories attached. Pressures to 325 psi, steam capacities to 34,000-lbs. per hour.

KEELER Type DK

Newest package unit in the Keeler line—a new, compact, low cost package unit (oil or gas fired) for small space requirements. Pressures to 325 psi, steam capacities to 45,000-lbs. per hour.



Write For Bulletins

No. F-14: Type CP Package Boilers
No. M-2A: Type CPM Package Boilers
No. DK-1: Type DK Package Boilers

KEELER WATER TUBE Boilers

E. KEELER CO.

100–200 West St. • WILLIAMSPORT, PA.

—OFFICES IN PRINCIPAL CITIES—

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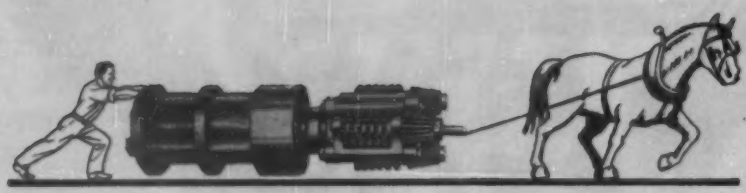

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waste time, labor, and money

Even if you rarely use tube cleaners, you can't afford to be without a powerful new ROTOJET. A ROTOJET should save you enough in time, labor, and air in one cleanout to pay for itself. You won't believe a tube cleaner can pack such tremendous power until you try the new ROTOJET.

Get a new
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Model S-530 ROTOJET Air-driven Motor with swing-frame head for 3¼ - 3-13/16 I.D. straight tubes.

We can ship promptly complete ROTOJET Tube Cleaners for all tube sizes and shapes. Roto heads, brushes, universal joints, air valves, lubricators, hose, and accessories are stocked ready for shipment.

Wire or phone us if you are in a hurry.

ELLIOTT COMPANY-ROTO DIVISION

147 Sussex Ave. Newark 1, N. J.

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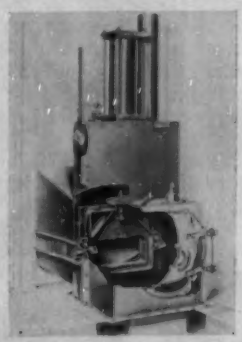
company, is sufficiently powerful to operate control valves and other pneumatic control equipment.

This closed-loop control is claimed to be largely unaffected by external changes in voltage, air supply, temperature and pressure. It provides high speed response and may be adjusted to give a full change of air pressure output for a 2-ft change in the level of a hydrocarbon or similar low dielectric material. An air output signal may be connected for either forward or reverse operation. Fielden Instrument Div., Robertshaw-Fulton Controls Co.

25—ASH GATE and feed housing for flooded type bottom hoppers

Combining a simple method of providing a tight seal to hold a head of water in the ash hopper and a convenient means of regulating flow of ash and water, this ash gate and feed housing unit is said to provide watertightness and accurate flow control. The hydraulically operated,



vertical lift type gate is available with either 2- or 3-ft wide openings. A wedging device, which holds the door in closed position to maintain a head of water in ash storage hopper works like this: Two lugs cast integral on door engage wedging-cams during the downward (closing) stroke of door. These cams rotate on stationary shafts to thrust door against frame, and each is counterweighted to swing free of door lugs when door is raised, while a stop limits movement of cam and positions it for next downward movement of door.

Hydralic cylinders for operating the gate are available for fresh water or oil operation. Parts can be supplied for clean salt water operation. Flanged bottom permits bolting unit to a clinker grinder, sluice-way or feed hopper. The Allen-Sherman-Hoff Co.

26—AIR VALVE is three-way solenoid pilot-operated

The S-3 Series 3-Way Solenoid Pilot Operated Air Valve offers a bubble-tight shut off, it is announced, and is non-corrosive throughout. Its compact design is said to combine simplicity and adaptability for application on air clutches, air brakes, power feeds and other pneumatic equipment. It operates without springs. By rotating pilot head, valve can be used normally open or normally closed. The solenoid has a low amperage solenoid coil that operates on most a-c and d-c voltages (with power consumption of 10 w maximum) and directs only two internal moving parts: spool and solenoid plunger. Each valve has a full pipe capacity with operating

MARLEY IS TESTING COOLING TOWERS

AND HERE IS THE RECORD

TEST NO.	TYPE OF SERVICE AND LOCATION	SPECIFIED CONDITIONS				TEST RESULT	
		Gallons Per Minute	Hot Water Temp.	Cold Water Temp.	Wet Bulb Temp.	[1]Degrees Cold Water Temp.	[1]Percent Capacity
1	Air Conditioning—West Coast	400	90°	80°	70°	+0.80°	+9.4%
2	Air Conditioning—Gulf Coast	6,500	101.3°	88.5°	80°	—0.40°	—4.3%
3	Chemical Plant—East Coast	18,500	104°	89°	76°	+0.50°	+3.8%
4	Chemical Plant—East Coast (1 of 4 duplicate units)	27,500	103°	88°	76°	—0.40°	—3.2%
5	Power Plant—Southwest	57,500	109.6°	92.6°	78°	—0.04°	—0.4%
6	Petroleum Refinery—Gulf Coast	3,400	115°	80°	70°	+0.90°	+8.5%
7	Power Plant—South Central	83,000	108.1°	90°	76°	—0.04°	—0.4%
8	Power Plant—Mountain States	45,000	105°	83.7°	63°	+0.20°	+0.8%
9	Petroleum Refinery—Gulf Coast	15,000	111°	90°	82.5°	+0.70°	+7.7%
10	Petroleum Refinery—Gulf Coast	36,570	120°	90°	82°	—0.60°	—4.4%
11	Power Plant—Southwest	70,450	102.6°	86°	70°	—0.86°	—4.4%
12	Power Plant—Southwest	70,450	102.6°	86°	70°	—0.51°	—2.7%
13[2]	Power Plant—East Central	13,000	101°	85°	75°	—3.70°	—24.3%
14	Power Plant—Mid-Central	44,000	100°	86°	74°	+0.45°	+4.0%
15	Power Plant—South Central	83,000	108.1°	90°	76°	—0.80°	—4.3%
16	Chemical Plant—South	40,000	103.3°	85°	78°	—0.30	—3.0%
17	Power Plant—North Central	37,000	100.5°	83°	72°	+1.20°	+9.6%
18	Petroleum Refinery—East Coast	15,570	115°	85°	76°	+1.10°	+9.0%
19	Power Plant—Mountain States	65,000	101.7°	82°	63°	+0.78°	+4.1%
20	Chemical Plant—Gulf Coast	40,750	123°	90°	80°	—0.16°	—1.2%
21	Chemical Plant—Gulf Coast	11,000	116°	90°	80°	+1.80°	+13.2%
22[3]	Retest of Tower Reported in No. 14	44,000	100°	86°	74°	+0.45°	+4.0%
23[4]	Retest of Tower Reported in No. 11	70,450	102.6°	86°	70°	+0.20°	+1.1%
24[4]	Retest of Tower Reported in No. 12	70,450	102.6°	86°	70°	+0.33°	+1.8%
25	Petroleum Refinery—East Central	6,000	125°	90°	75°	—0.46°	—2.6%
26[5]	Petroleum Refinery—Gulf Coast	10,000	120°	85°	79°	+0.30°	+3.2%
27	Power Plant—Southwest	72,000	112°	92°	78°	+1.05°	+6.6%
28	AEC—East Central (1 of 2 duplicate units)	62,798	132.3°	90°	80°	+0.31°	+3.5%

NOTES: 1) Plus indicates capacity exceeding specified performance; minus denotes deficiency. 2) Tested to determine loss of performance due to extensive settling of bann and resultant misalignment of structure. 3) Retested at higher wet bulb. 4) Retested at contract (higher) horsepower. 5) Tested in accordance with Cooling Tower Institute test procedure (ATP-105 adopted May 1, 1955) and observed by CTI representative.

HERE IS THE RECORD — a consecutive list of ALL acceptance tests conducted by Marley during the 1954-1955 test seasons. All are full-scale tests conducted in strict accordance with specified methods.

Towers tested were of many sizes and capacities, operating under widely varying conditions. Geographically, these tests spanned the entire country and included towers sold since 1950, located at elevations up to 5,000 feet.

HERE IS THE RECORD that offers more **positive assurance of performance satisfaction than any guarantee ever written.** It shows why Marley has the complete confidence to insist that you TEST YOUR TOWER.

MARLEY

The Marley Company

Founder-Member Cooling Tower Institute

Kansas City, Missouri

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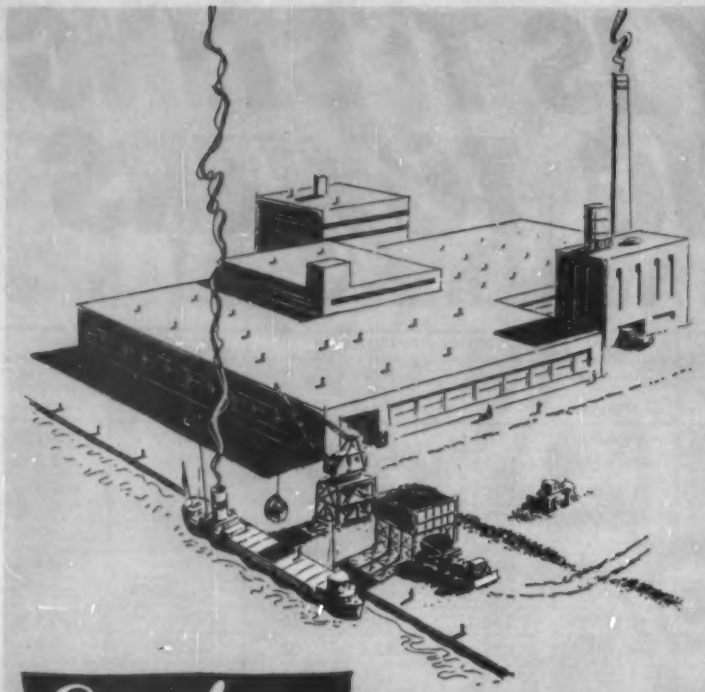

Southern HELPS INDUSTRY

increase Efficiency in Boiler Room Operation

— which of course, helps reduce steam costs. First, SOUTHERN'S constantly expanding operations assure you more diversified coal selection; precise application; faster, more economical shipment, and dependable supply. (SOUTHERN produces in excess of 14,000,000 tons annually). Secondly, SOUTHERN'S modern methods of washing, drying, dust-treating and grading produce coals precisely conforming to specific industrial requirements. Ash forming and sulfurous impurities are reduced to a practical minimum. Improved energy content delivers more low cost BTUs per ton, and daily laboratory tests maintain size consists in dependable ratios. A trial run will prove the efficient performance of these superior quality coals — and SOUTHERN'S engineers will help you with analyses, selection and application.

SEND FOR THIS FREE BOOK

"Coal and its Combustion" — written by Joseph Harrington, Southern's eminent engineering counsel; noted authority on Coal; its chemistry, preparation, efficient utilization, storing and handling.

YOU CAN RELY ON SOUTHERN'S ENGINEERED INDUSTRIAL COALS

Southern Coal Company, Inc.

GENERAL OFFICE: 333 NORTH MICHIGAN AVENUE • CHICAGO 1, ILLINOIS
OFFICES IN: LOUISVILLE, MEMPHIS, NASHVILLE, ST. LOUIS
SINCLAIR COAL COMPANY, KANSAS CITY 5, MO., WESTERN REPRESENTATIVE

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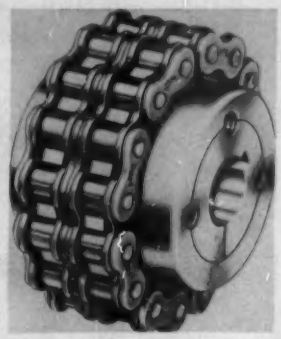
pressure ranging from 30 to 150 psi. It can be mounted in any position — base-mounted if desired. Ample lead lengths of 24 in. are provided. Internal parts are accessible by removing bottom nut. Airmatic Valve, Inc.

27—CHAIN COUPLINGS offer several design advantage

Taper-Lock Chain Couplings are of a flexible type and permit sufficient relative movement between hubs to accommodate slight angular and parallel shaft misalignment. They are designed to provide a strong, yet compact, direct

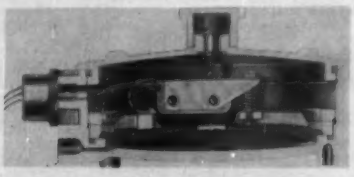


coupling of the shafts. Among features announced for these couplings are Taper-Lock bushings, readily available from distributors in desired sizes. They permit easy installation on full or normally undersized shafts, it is noted, yet give the equivalent of a shrunk-on fit.

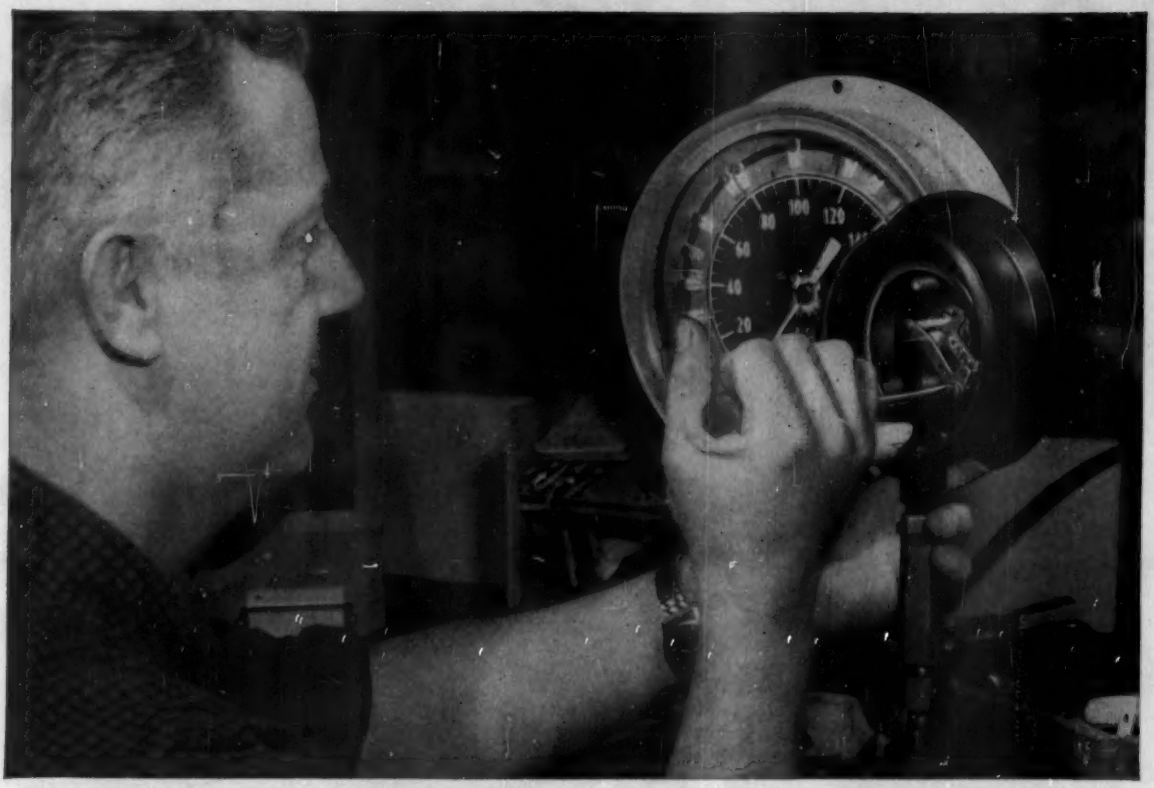
The chain is double-width and conforms to ASA specifications — the additional bearing area of the full width permitting higher horsepower ratings and longer wear life, according to company. Quick disconnecting of the shafts is possible by removing one coupling pin and unwrapping the chain from the hubs. Two more teeth are furnished in each flange than are found in many couplings, a design feature claimed to contribute to long life and power transmitting capacity. Dodge Mfg. Corp.

28—PRESSURE SWITCH senses differences

Diaphragm Pressure Switch 227 accurately senses a pressure difference from 0 to 45 in. of water between a variable and a reference pressure, it is announced, with a fixed actuation value of 0.5 in. of water. Reference pressure must be



air or an inert gas; variable pressure may be a liquid or gas. Switch will actuate an electric circuit on an increase or decrease of a predetermined pressure difference. It can be readily adjusted by means of an external adjustment screw for field setting. Switch is not sensitive to jarring or vibration and its tamper-proof external adjustment keeps it from being accidentally disturbed. It will



Accurate gauge — accurate setting. Worker calibrates a pressure gauge equipped with a "K" Monel Bourdon tube at the Manning, Maxwell and Moore plant in Stratford, Conn. The company was the first to use long-lasting, corrosion-resisting "K" Monel for Bourdon tubes in a pressure range of 15 psi to 100,000 psi.

For high-pressure, high-temperature service

Gauges with "K" Monel Bourdon tubing ideally suited to meet today's needs

Can your gauges stand up to higher operating pressures, higher temperatures, and corrosion?

Ashcroft gauges made with Bourdon tubing of "K"® Monel can! Successfully used in a pressure range of 15 psi to 100,000 psi, they may be the answer to your problem.

Like all Inco Nickel Alloys, "K" Monel is strong . . . tough . . . corrosion-resisting. In addition, it has the low hysteresis and drift needed to assure gauge accuracy, and the good fatigue strength necessary for long-term service.

In short, "K" Monel helps bring to your gauging equipment hairline accuracy . . . trouble-free performance . . . and extended life. *Check for "K" Monel Bourdon tubing in the gauges you buy.*

And remember that "K" Monel — or one of the more than 50 other Inco Nickel Alloys — may provide the answer to some of your other equipment problems, too. Particularly if those problems involve high pressures, high temperatures, and corrosion. For any help you need in making a selection, don't hesitate to call upon Inco's Technical Service Section. They're always glad to work with power plant men on specific problems.

Meanwhile, Technical Bulletin T-9, containing valuable material on *Engineering Properties of "K" Monel,* may prove helpful. Write us for a copy.

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

More POWER for you . . . with "K" MONEL INCO TRADE MARK **NICKEL ALLOYS**

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Only CONSECO Offers Such SERVICE

CONSECO SERVICE is two-fold. **On one hand, our engineers will design, redesign, build, erect, and install practically everything in a modern power or chemical processing plant except the building, electrical equipment, and turbo-generator. On the other hand, we will dispatch an expert crew to your plant for retubing, rebuilding, and maintenance of any type of tubular equipment, or metallizing . . . ANY HOUR, DAY or NIGHT, SUNDAYS and HOLIDAYS. Conseco's coordinated manufacturing and maintenance services meet every need in the Power and Processing fields.**

CONDENSER SERVICE & ENGINEERING CO., INC. CONSECO

Designers and Builders of Equipment for Power, Refining, Chemical and Marine Industries

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HOBOKEN, N. J.

Equipment Designed and Built by CONSECO

Conseco and its subsidiaries design, build, and install power and processing equipment and accessories, some of which are listed here. Purchasers of Conseco equipment benefit from our maintenance division's quarter century experience in rebuilding, modernizing, and maintaining our own as well as competitors' equipment. This coordination assures easy accessibility for maintenance and low operating cost. Send for bulletins covering equipment in which you are interested.

HEAT EXCHANGERS
CONDENSERS
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CENTRIFUGES
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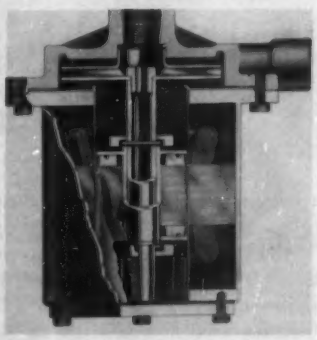
operate in any position — no leveling or special mounting is necessary. It incorporates a U.L. approved SPDT snap action switching element rated for a-c and d-c. A splash-proof housing protects it from dust or damage in exposed installations. Barksdale Valves.

29—VIBRATION MONITOR detects mechanical malfunctions

This explosion proof vibration monitor is announced for detecting failing bearings or unbalance or other mechanical malfunction. Applications include gas engines, pump motors, large fans and blowers. The unit is designed to offer 24 hour supervisory protection for infrequently attended equipment by actuating a warning, or causing a shutdown the instant a malfunction develops. It may be provided with either a SPDT or a DPST normally open switch, and an adjustment provides for a wide range of normal vibration levels. Electrical rating is 5 amp, at 115 or 230 v a-c, resistive or inductive. The aluminum explosion proof housing is designed for Class I, Group D, Class II, Groups E, F, and G, and Class III locations. The monitor is also available in weather proof housing with external reset operator and locking means. The Beta Corp.

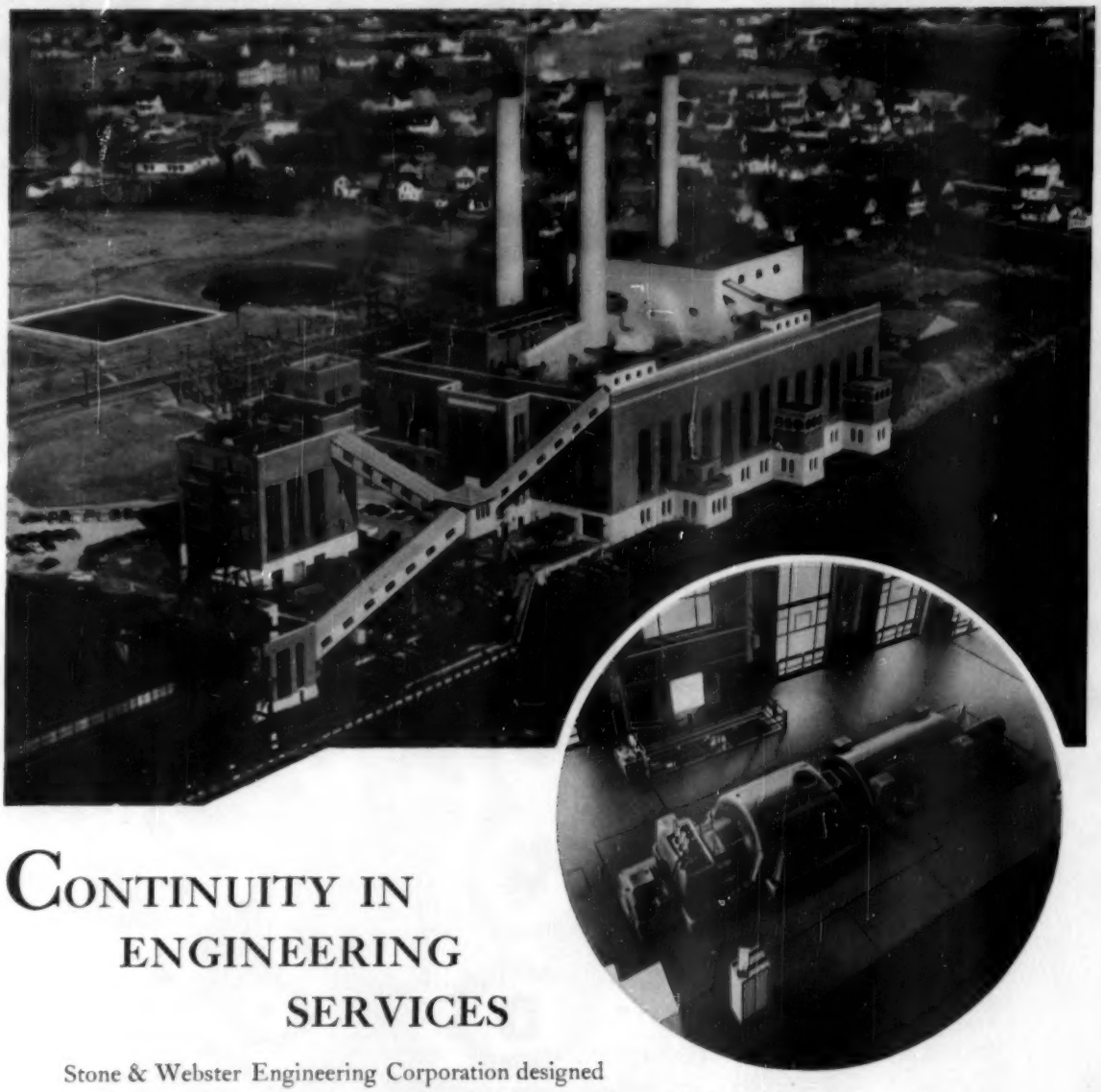
30—CANNED ROTOR PUMP available at lower cost

New methods of construction, new materials and a new cooling circuit are offered in the Model S series of seal-less centrifugal pumps. In addition, these new ½ through 3 hp units are priced from $100 to $150 lower than their older but still available counterparts, company's Model C series, it is announced. The new pumps utilize fabricated parts



which can be clad with such metals as titanium, zirconium and Hastelloy series metals, as well as Monel, Carpenter 20 and various stainless steels.

About 400 per cent more bearing area is offered by the bearings, it is noted. Made of Graphitar, these bearings are semi-floating and can be replaced from front or rear of pump without breaking piping connections. In the cooling and fluid circulation system, pumped fluid passes from pump chamber, through front bearing, into rotor chamber and through the rear bearing, returning to the eye of the impeller through the hollow rotor shaft. No external cooling circulation tube is used. Capacities of the Model S series range to 170 gpm, heads to 150 ft. Standard temperature and pressure limits are 350 F and 150 psi. Chempump Corp.



CONTINUITY IN ENGINEERING SERVICES

Stone & Webster Engineering Corporation designed and constructed the first unit of Somerset Station for Montaup Electric Company at Somerset, Massachusetts in 1924. Three years later the Engineering Corporation designed and built a second unit; in 1942 the first large high pressure controlled circulation boiler in this country and a third unit were installed; in 1947 a fourth unit was added and a fifth unit is now on the line.

Four-fifths of all the construction work of the Corporation amounting to well in excess of three billion dollars has been in the form of "repeat orders" from clients.

With the fifth unit shown above, Somerset Station has a net capability of 210,000 kilowatts

Write or call us for detailed information as to how our engineering, design, construction, report and appraisal services may be of assistance to you.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY *of* STONE & WEBSTER, INC.

New York Boston Chicago Pittsburgh Houston San Francisco Los Angeles Seattle Toronto

Bailey Recorder for receiving pneumatic and electric signals.

Pick any four, plug in, and record

Here is a receiver recorder, custom-built *by you* to meet your needs, no matter how changeable, how complex. On a single chart you can record any four measured variables—and interchangeable receivers permit new combinations almost at will.

Individual plug-in pneumatic or electronic receivers—and corresponding integrators—are interchangeable in the four identical frame slots. You can select any combination; even including two receivers and their two integrators.

Think what this can mean to you! Parts inventories are minimized; re-use of components keeps instrumentation costs economically low when cycle changes are frequent—and you can even tie in with your existing transmitters.

Ask for Product Specification E12-5.

Measured Variables

- % combustibles
- combustion
- conductivity
- density
- differential
- draft
- flow
- liquid level
- % oxygen
- pH
- position
- pressure
- ratio
- smoke density
- specific gravity
- speed
- temperature
- vacuum

F12-1

ONLY BAILEY OFFERS ALL THESE ADVANTAGES IN A SINGLE RECORDER

- Pre-calibrated plug-in receiver units
- Up to four pneumatic or electronic receivers —or two receivers and two integrators
- Any four variables on one chart—easily read and interpreted
- A full year's ink supply at one loading
- Faster ordering—from stock
- Minimum inventory of parts
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BAILEY METER COMPANY

1040 IVANHOE ROAD

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Controls for Power and Process

BAILEY METERS

Controls for TEMPERATURE · PRESSURE · GAS ANALYSIS · FLOW · LEVEL · RATIO · DENSITY

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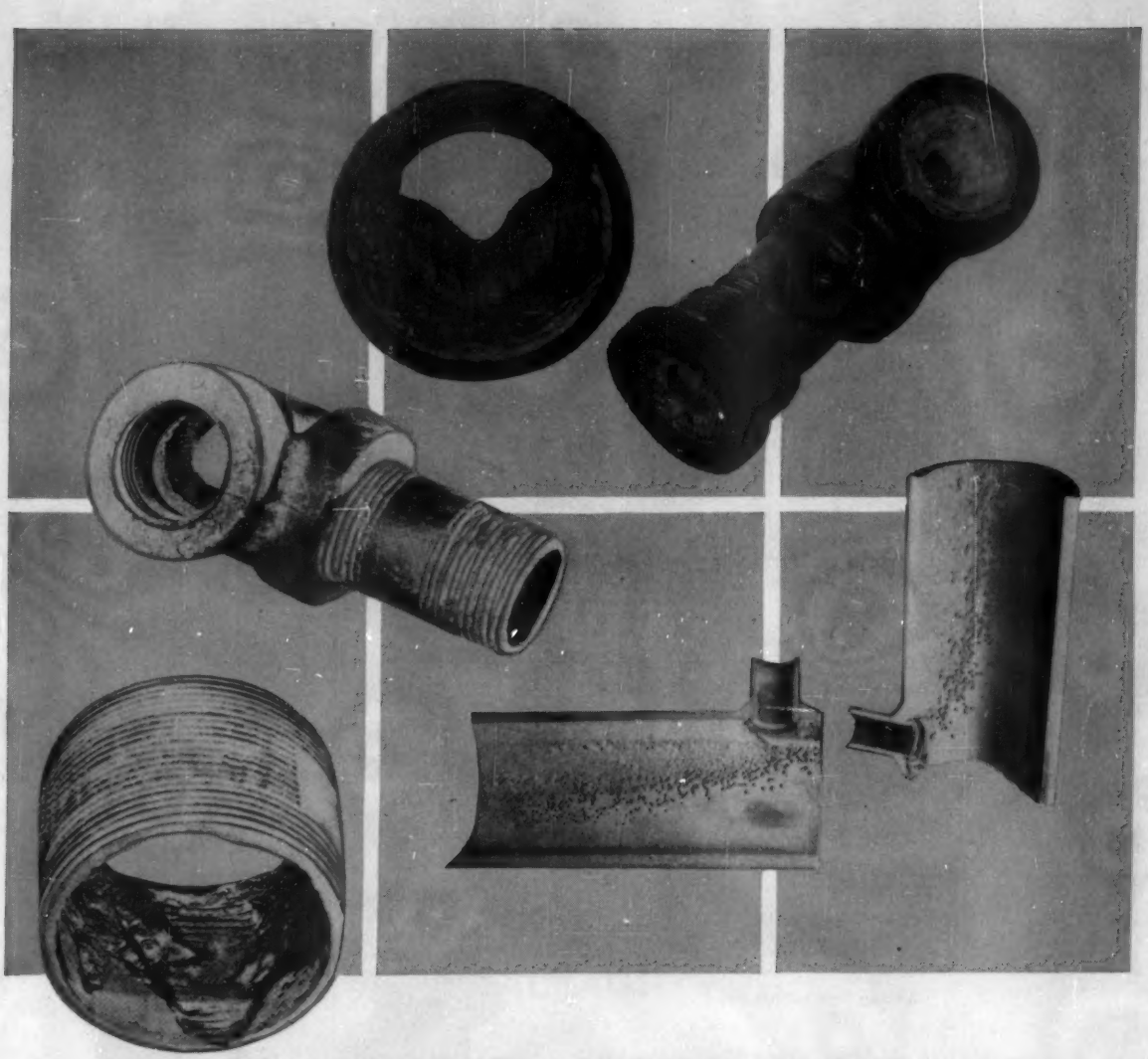

WHAT'S YOUR TROUBLE?

Each of these destroyed parts had to be taken out of service because of incomplete or inadequate water treatment. Replacement meant loss of steam production . . . new equipment expense . . . added labor-repair costs.

DEARBORN COMPLETE WATER TREATMENT SERVICE eliminates this by providing trouble-free water—a vital necessity to every user of industrial steam. Dearborn's many years of leadership in the field of water treatment will help keep your power plant operating economically.

CALL ON YOUR DEARBORN SALES ENGINEER for (1) analysis of raw water (2) recommendation of test procedures (3) proper treatment (4) a manually or automatically controlled feeding system.

Dearborn®

combatting corrosion wherever it occurs

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Merchandise Mart Plaza, Dept. PG
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Please send me
- ☐ Internal Treatment Bulletin 5000
- ☐ Filmeen Bulletin 5013-A
- ☐ Dearborn "659" Bulletin 5008
- ☐ Have a Dearborn Sales Engineer call.

Name.....

Company.....

Position.....

Address.....

City..... *Zone*..... *State*.....

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One of many advantages of 90/10 Cupro-Nickel

WELDABILITY

Welding head on filter shell

One of the relatively new copper base alloys is 90/10 Cupro-Nickel, which is coming into increased use as a result of experience with it. Revere offers it in sheet and plate, pipe and tube. It is highly resistant to corrosion and erosion, particularly in salt or brackish water. In addition it can be cold or hot worked, welded, soldered and polished. Because its nickel content is less than the older 70/30 alloy, it is priced lower.

The item shown here is a 90/10 Cupro-Nickel filter for aviation gasoline, designed and fabricated by the Warner Lewis Company, Division of Fram Corporation, Tulsa, Oklahoma, for the U. S. Navy. Heads and shell are 1⅛" thick. Revere was given the opportunity to collaborate with the Warner Lewis manufacturers on welding, which was successfully accomplished by the metallic arc process, using Inco 70/30 Cupro-Nickel electrodes. The vertical weld on the shell was X-rayed 100% and found satisfactory to pass Navy inspection. Because of the thickness of the metal, it was decided to form the heads hot at around 1690° F. The forming was done by the Hackney Iron & Steel Co., Enid, Okla., which also consulted with Revere.

Warner Lewis Company of Tulsa, with representatives in 30 cities, are specializing on all types of alloy design and fabrication and inquiries of this nature are invited.

If you wish information regarding the selection, welding, or working of copper and its alloys and aluminum alloys, see the nearest Revere Sales Office.

Completed aviation gasoline filter, made of 90/10 Cupro-Nickel

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N.Y.

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities, Distributors Everywhere.

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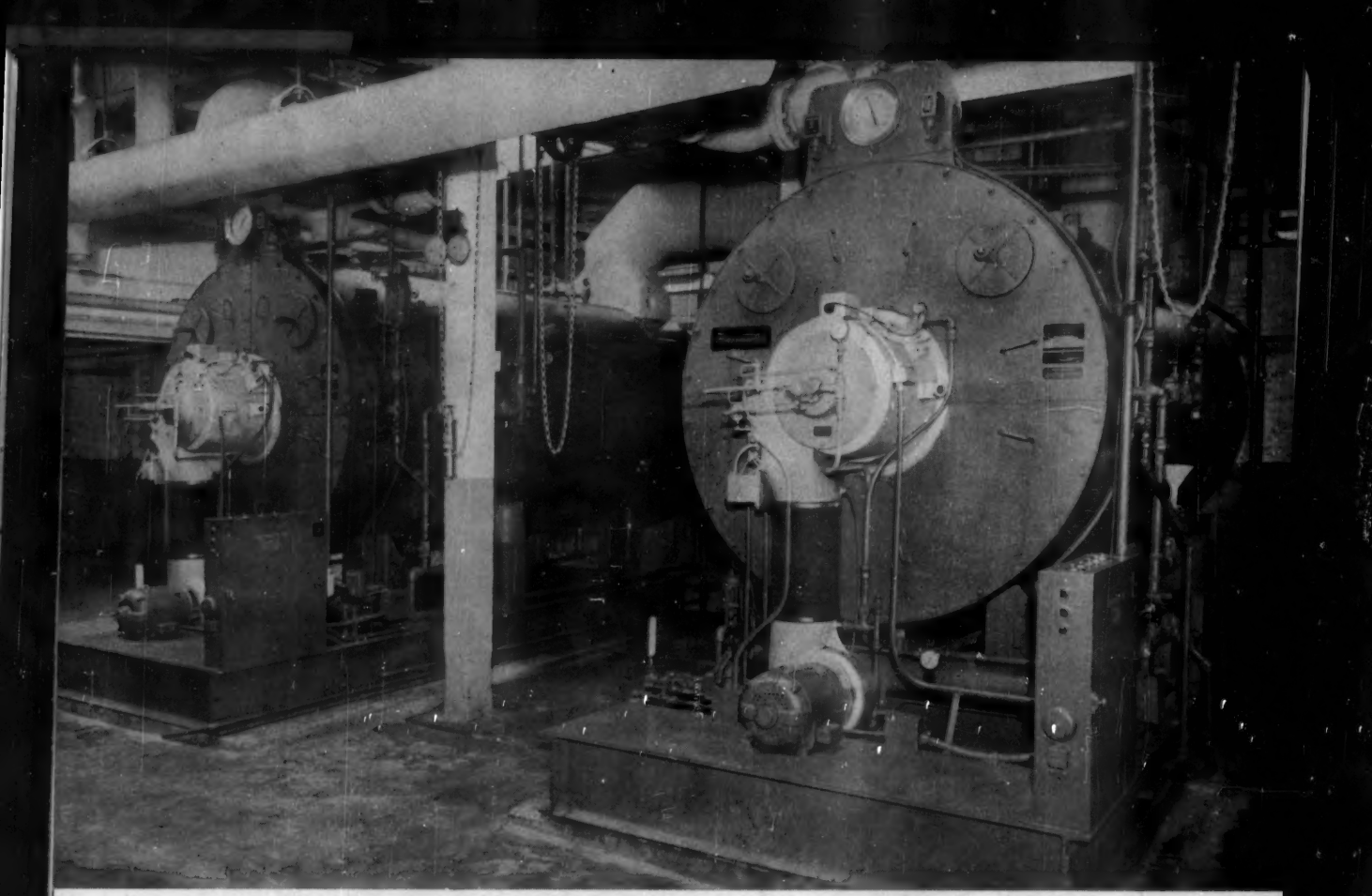


$9,040 Saving in Steam Cost

WITH *Powermaster*® PACKAGED AUTOMATIC BOILERS

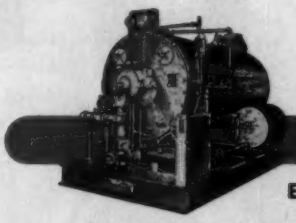
You get MORE than low-cost steam with Powermasters:

- ★ Low-cost, space-saving installation
- ★ Fast steaming
- ★ Instant response to load changes
- ★ Quick fuel change-overs
- ★ Clean, dry steam
- ★ Automatic operating and safety contro
- ★ High fuel economy at all loads
- ★ Clean, quiet operation
- ★ Smokeless combustion
- ★ One-source responsibility for complete unit
- ★ Nation-wide factory-trained service organization
- ★ Pay-As-You-SAVE Purchase Plar

These two 200 HP *Powermaster* Packaged Automatic Boilers are saving 50% of steam costs annually for a large manufacturer of clothing. In addition, they are providing hotter, drier steam for processing and comfort heating.

Completely factory assembled and fire-tested *Powermasters* have gained world-wide acceptance as dependable producers of low-cost steam or hot water. And now, you can put a *Powermaster* in your plant or building on the Pay-As-You-SAVE Purchase Plan, that helps you pay for your new boiler out of its own savings.

Write for Bulletin 1220, or ask our representative to explain why it pays to modernize with *Powermaster*.



Powermaster®
PACKAGED AUTOMATIC BOILERS
In sizes to 500 HP; pressures to 250 psi.

ORR & SEMBOWER, INC.
Established 1885 • Morgantown Road, Reading, Pa.

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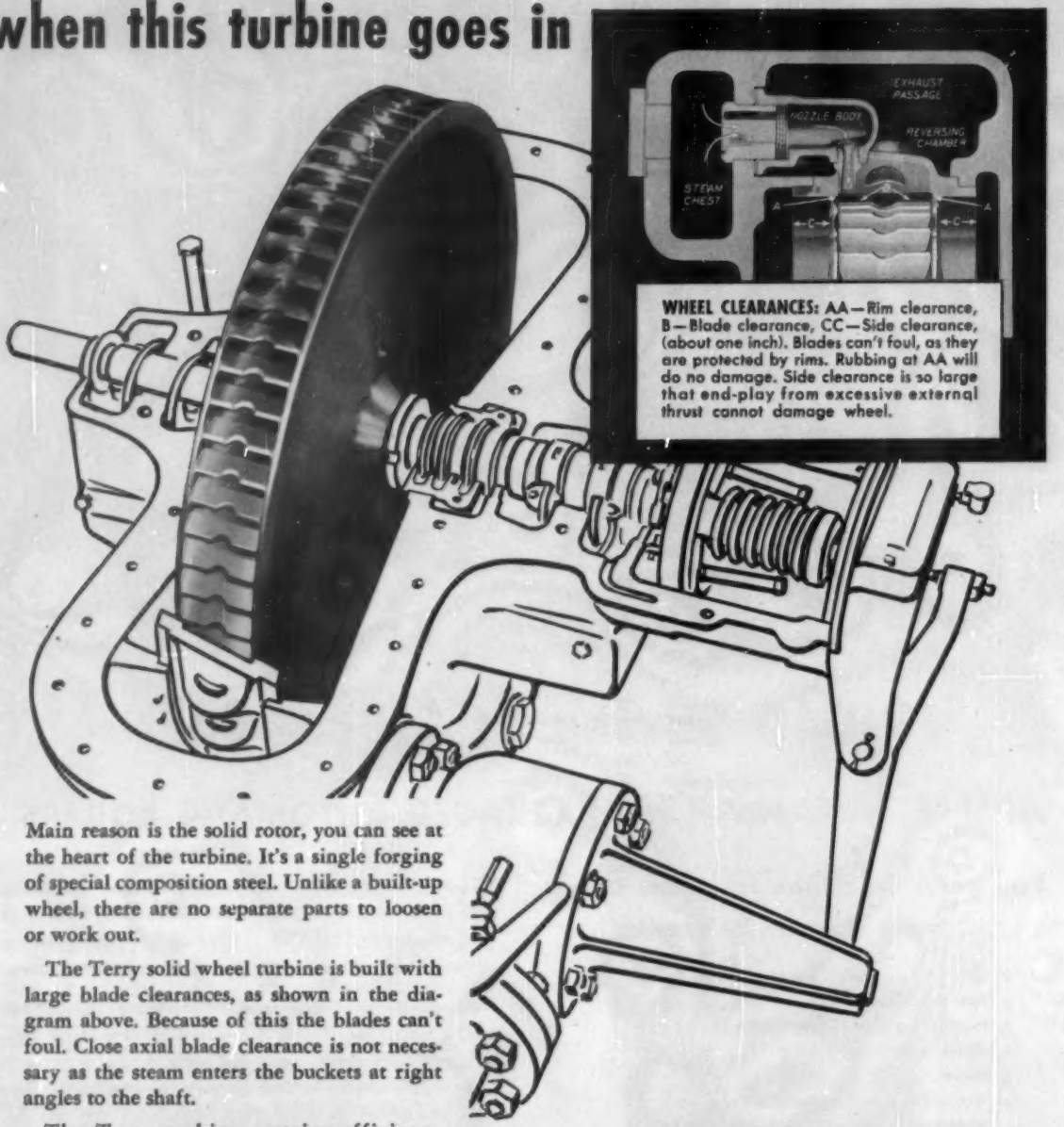
WHY TROUBLE GOES OUT

when this turbine goes in



WHEEL CLEARANCES: AA—Rim clearance, B—Blade clearance, CC—Side clearance, (about one inch). Blades can't foul, as they are protected by rims. Rubbing at AA will do no damage. Side clearance is so large that end-play from excessive external thrust cannot damage wheel.

Main reason is the solid rotor, you can see at the heart of the turbine. It's a single forging of special composition steel. Unlike a built-up wheel, there are no separate parts to loosen or work out.

The Terry solid wheel turbine is built with large blade clearances, as shown in the diagram above. Because of this the blades can't foul. Close axial blade clearance is not necessary as the steam enters the buckets at right angles to the shaft.

The Terry turbine sustains efficiency through the years. Reason: The power producing action of the steam takes place on the curved surfaces at the back of the buckets, so blade wear which might occur is of little consequence.

Bulletin S-116 tells more about these *"Work Horses of Industry."* Send for a copy today.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

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For lowest cost steam generation, GE burns coal the modern way

General Electric's Major Appliance Division in Louisville, Ky., has five product manufacturing buildings, a warehouse and service buildings—over 4 million sq. ft. under roof. To generate all steam necessary for process work and heating requirements of this vast area, GE's power plant burns coal the modern way. Coal was chosen for two reasons. One, a careful fuel cost study disclosed that, on a straight economic basis, coal would give GE the lowest cost steam generation of all fuels. Second, availability of supply was considered and again coal won over other fuels. In addition, full mechanization of GE's power plant has facilitated all details of coal handling and ash removal while completely eliminating any possibility of air pollution.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

NATIONAL COAL ASSOCIATION
Southern Building, Washington 5, D. C.

Consult an engineering firm

Designing and building hundreds of heating and power installations a year, qualified engineering firms can bring you the latest knowledge of fuel costs and equipment. If you are planning the construction of new heating or power facilities—or the remodeling of an existing installation—one of these concerns will work closely with your own engineering department to effect substantial savings not only in efficiency but in fuel economy over the years.

facts you should know about coal

In most industrial areas, bituminous coal is the lowest-cost fuel available. • Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar. • Automatic coal and ash handling systems can cut your labor cost to a minimum. Coal is the safest fuel to store and use. • No smoke or dust problems when coal is burned with modern equipment. • Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

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For wider adaptation . . . and unmatched Service Life . . . . .

Vogt GENERAL GP PURPOSE * DROP FORGED VALVES

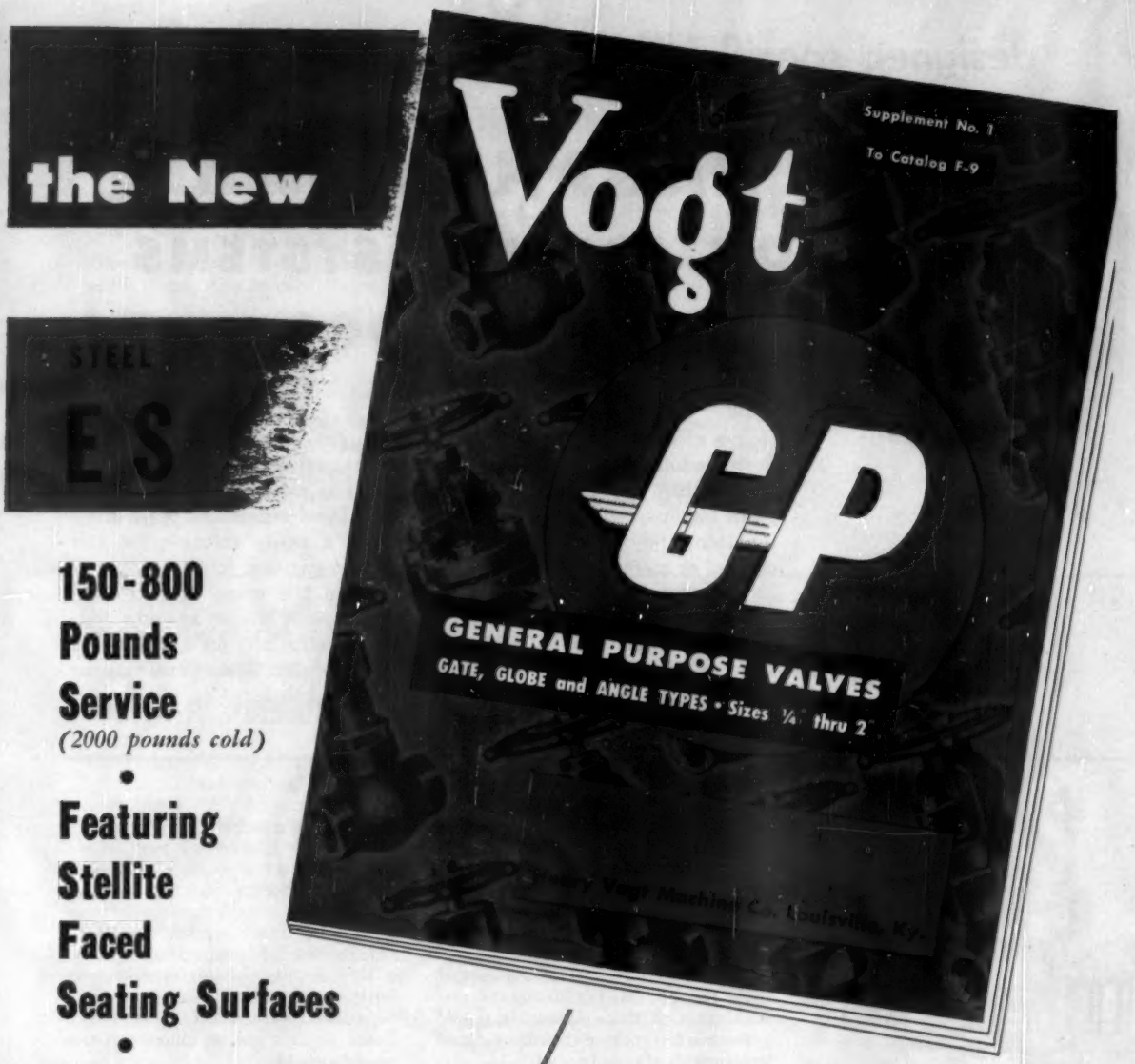
We invite you to inquire into the savings which the new line of Vogt GP Drop Forged Steel Valves can make possible in your operations. Not only do their many unique and exclusive features make them more economical of operation, but their broad adaptability to so many industrial applications permits a substantial reduction in operating overhead. Service life, too, is enhanced with Stellite faced seating surfaces which are available at no extra cost along with many other trims.

FREE
Supplement No. 1 to Vogt Catalog F-9

* GP Valves completely fill the demands of industry for a line of compact, lighter weight, shorter face-to-face valves.

Still retaining the safety and ruggedness inherent in a wrought material, these new forged steel screw and socket weld end valves, in sizes from ¼" through 2", are rated 800 pounds at 850°F. and 2,000 pounds at 100°F.

the New



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150-800 Pounds Service
(2000 pounds cold)

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Featuring Stellite Faced Seating Surfaces

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Sizes ¼" to 2"

This 32-page catalog illustrates and gives complete specifications on 11 types of the new Vogt GP forged steel gate, globe and angle valves. Send for your free copy — for ready reference in purchasing. Use the coupon for convenience.

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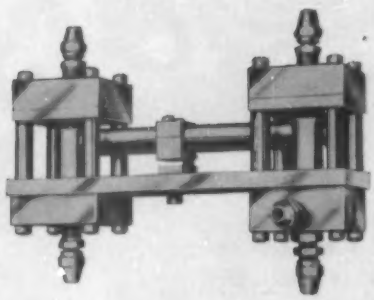
designed specifically for steam plant use . . .

HAGAN AUTOMATIC COMBUSTION CONTROL SYSTEMS AND COMPONENTS

Hagan's long experience in the design of Automatic Combustion Control Systems has produced a line of instrument and control devices which are reliable, accurate and versatile. Each is available to the power plant engineer as a standard component. Used separately or in combination, they provide the engineer with a ready solution for any control or metering problem he may wish to engineer locally.

The components listed are just a few of the many Hagan units which have given such good service in complete Hagan systems that they have been adopted in many plants as standard for a variety of services. For details as to construction or applications, consult your local Hagan engineer, or write to the address below.

HAGAN



Adds, subtracts, multiplies, divides or proportions up to 3 separate signals

HAGAN RATIO TOTALIZER

The Hagan Ratio Totalizer is a compact, pneumatically-operated unit for combining accurately a maximum of three incoming signal pressures to produce an output signal pressure in the ranges of 3-15 psig, 0-30 psig or 0-60 psig.

Standard elements are available for input pressures up to 500 psig. An adjustable fulcrum provides means of changing the relation between incoming pressures and the output signal. This feature permits adjustment of proportional band.

Two input signals, representing separate measured quantities, may be added, subtracted or reversed. Reset or rate action characteristics are adjustable.

Multiple Ratio Totalizers may be connected to select the higher or lower of two input signals, for splitting an output signal in proportional parts, or for securing the combined characteristics of proportional band, reset and rate action.

HAGAN

For measurement of liquid level, specific gravity, etc.

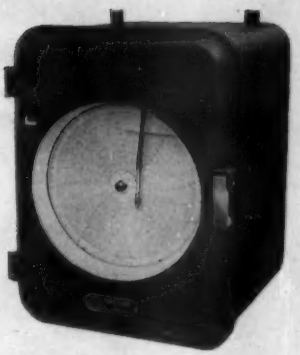
TYPE FRB DIFFERENTIAL TRANSMITTER

The Hagan Type FRB Differential Transmitter uses the Ring Balance meter construction to produce a pneumatic signal linear with the pressure differential imposed on the measuring element. Standard output signal pressure ranges are 3-15 psig, 0-30 psig and 0-60 psig.

Ring assemblies are available for measuring full scale differentials over a continuous range of 0.5" WC at 10 psig to 420" WC at 3000 psig. The full scale pressure differential for any ring assembly is easily adjustable over a continuous range of seven to one.

For accurate measurement of flow or differential — the most versatile instrument is the

HAGAN RING BALANCE METER



The Hagan Ring Balance Meter is a flow recorder or indicator, simple in design and extremely accurate over a wide range of measurements.

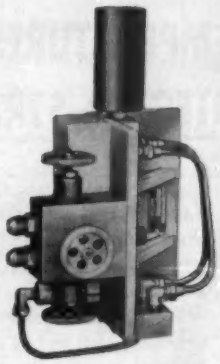
Check these many distinctive features of the Hagan Ring Balance Meter

- There is a complete series of interchangeable sensing elements for full scale differentials from 0.5" to 560" WC. Static pressures up to 10,000 psig.
- Ring assemblies available with ample power at all flow rates.
- The differential measuring range of any ring is adjustable over seven to one range.
- Dead weight check of calibration takes only a few minutes. Meter need not be disconnected from the line.
- Automatic compensation for such factors as fluid density, pressure and temperature is a standard attachment.
- The Hagan Ring Balance Dual Meter has two separate rings mounted in a single case, making independent measurement of two differentials or rates of flow, recorded on a single chart.
- Pneumatic or electric transmission available for most models.

HAGAN

For measurement of differentials up to 300 psi at static pressures up to 3000 psig

"DELTA P" PRESSURE DIFFERENCE TRANSMITTER



The Hagan "Delta P" Pressure Difference Transmitter is a compact instrument for measuring pressure differences at elevated static pressures and converting the measured value into a pneumatic signal pressure linear with pressure difference.

Full scale pressure difference measurement ranges from 0-50 psi to 0-3000 psi at static pressures up to 3000 psig. Signal pressure ranges are 0-30 psig and 0-60 psig.

The assembly employs directly opposed measuring bellows. No stuffing boxes or torque tubes are used. Seals are eliminated. Shutoff and bypass valves are integral and the assembly can withstand accidental application of full line pressure to either side of the measuring system.

The "Delta P" Transmitter is shock and vibration resistant.

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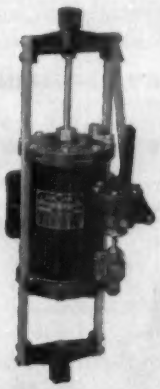
Muscles for industry

HAGAN POWER POSITIONERS



Hagan Power Positioners provide plenty of power for accurate positioning of dampers, valves and other mechanisms in response to pneumatic signals received from automatic or manual transmitters.

Movement of the piston is normally linear with signal pressure, but this relation may be characterized by shaping the cam of the integral feedback mechanism.

Standard signal pressure ranges are 3-15, 0-30, and 0-60 psig. The usual power medium is compressed air between 40 and 100 psig.

Cylinder sizes range from 4" to 12" bore and from 5" to 48" stroke.

Accessories for most models include air failure locks, manual operators, limit switches, covers, etc.

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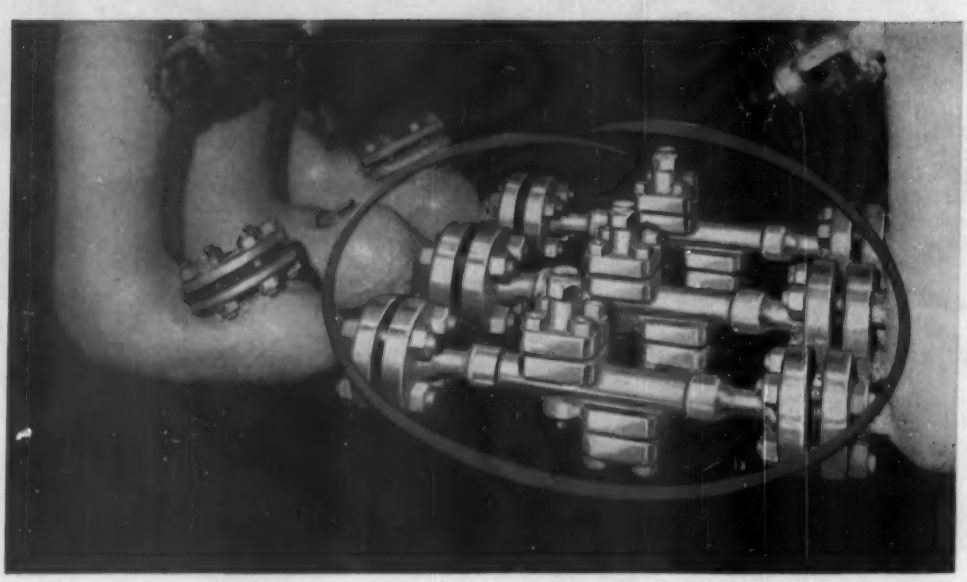
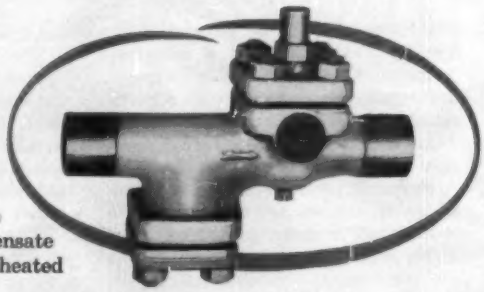


Three Yarway Integral-Strainer Impulse Traps draining main steam lines in large mid-west power plant. Other Yarway traps drain extraction lines in same plant. Yarway Integral-Strainer Impulse Traps are available with welding or flanged connections. Pressures 600, 1500 and 2500 psi.

HIGH STEAM PRESSURES AND TEMPERATURES CALL FOR YARWAY INTEGRAL-STRAINER STEAM TRAPS



YARWAY Integral-Strainer Impulse Steam Traps drain some of the hottest steam lines in the country—temperatures up to 1000° F and pressures as high as 2500 psi.

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Leading utilities and other high pressure steam plants appreciate the other YARWAY advantages, too, such as *small size, light weight, steel construction, easy maintenance.*

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SERIES 60 and 120

For all *normal* trap requirements, pressures to 400 and 600 psi.

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For *light loads* on tracer lines, steam mains, small presses, etc.

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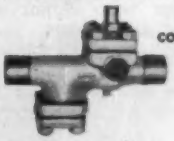
For *heavy loads* requiring extra high capacity steam traps.

INTEGRAL-STRAINER HIGH PRESSURE TRAP



For *high pressures, high temperatures.* (Flanged or welding connections.)

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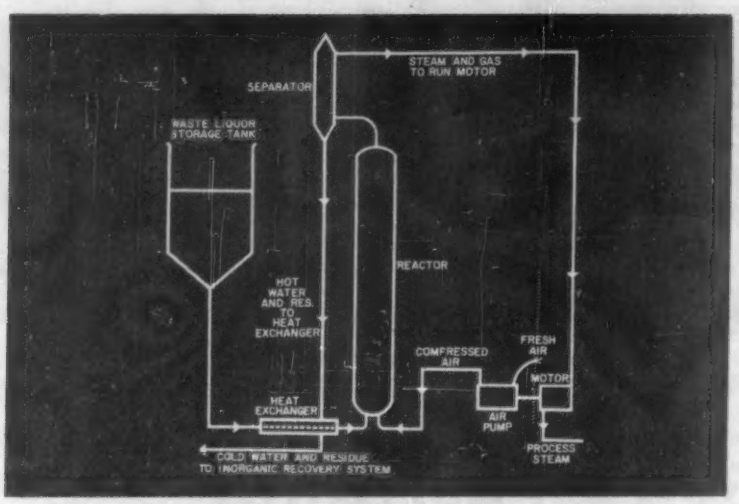


Compressed air and waste liquor feed into reactor vessel, combine to make steam

Organic Waste Burns Wet, Produces 2200-psi Steam

New process actually burns organic waste under water—either in suspension or solution—and produces excess steam for power or process use. Norwegian plant will be the first big installation

ORGANIC WASTE, long the villain in stream pollution, can now be burned submerged in the water it pollutes. Furthermore, it is not a low-temperature process — it generates steam at 2200 psi. The process is tagged the "Zimmerman Process" after the man who led its development at Sterling Drug, Inc.

Specifically, the Zimmerman Process pumps organic-laden water and air into a reactor vessel at 2200 psi. The organic fractions undergo rapid oxidation though dissolved or suspended in the polluted water. This rapid oxidation gives off heat to the water by direct convection, and the water flashes into steam. Inorganic chemicals, which are present in many industrial wastes, can be recovered from the steam in a separate chamber.

Heat from an external source is applied only to start the process. Thereafter, the process requires only about 12 to 20 per cent of its own heat to keep the process going — at least, these are the figures in a pulp mill operation. The remaining 80 to 88 per cent can be utilized as process steam or to drive turbines for electrical or mechanical power.

Aside from pilot plant installations, the first plant to use this principle seriously will be a Norwegian firm which makes pulp and related products. The firm, Aktieselskapet Borregaard, will build a $3,000,000 Zimmerman Process plant to serve its 500-pulp-ton mill at Sarpsborg, Norway. This large unit will clean up the waste pulp liquors while reclaiming the valuable inorganic chemicals and furnishing the mill with 220,000 pounds steam per hour at 2200 psi. At the price of fuel oil in Norway, this would represent an annual fuel bill in excess of $1,000,000.

It is interesting to note that Borregaard's Sarpsborg plant is located where there is no stream pollution problem, and ample water power is at hand to provide their electrical requirements. Process steam, however, was essential and expensive enough to justify the $3,000,000 expenditure. Equipment has already been ordered for Borregaard's installation.

Pilot Plants Operated

A series of pilot plants has been built and tested for the processing of a wide variety of organic wastes ranging from spent pulp liquors to sewage sludge and garbage. This research is continuing and will be supplemented by operating data from full-scale plants. The advantages of an effluent purifying plant that pays instead of costs is very appealing to industry and government alike.

Sterling has filed more than a dozen patent applications on its process features and basic concepts. Four patents have been granted in this country, and several foreign patents have been granted as well. Borregaard has been named exclusive agent for licensing the Zimmerman Process in Europe under Sterling's patents.

Further licensing will be contracted to others in the future on a royalty basis. Sterling will design and supervise construction of the plant facilities and — when the designs and specifications are adhered to — will guarantee performance.

James Hill, Jr., Sterling's board chairman, said, "For many types of industrial plants, which have waste of substantial organic content, elimination of stream pollution becomes economically attractive. Since the process converts such waste into power, the waste becomes too valuable an asset to be piped into streams. In addition, the process permits the recovery, for re-use, of whatever inorganic chemicals the waste may contain.

"We recognize that the Zimmerman Process is more attractive commercially to some than to others. At the same time, we believe the process may well provide a cheaper means than alternative methods for the disposal of sewage and other dilute aqueous materials low in organic content. Under any circumstances, the process, wherever installed, will effectively eliminate stream pollution caused by organic waste."

Any Concentration Burns

Organic waste in any concentration will burn submerged in the new process. This does not mean that it is always desirable to use the combustion process of waste treatment, however; it just means that the decision on whether or not to use it will be made on economic rather than technical factors.

"Fuel" concentrations of about 3000 Btu per gallon of waste solution are the economic minimum for a plant that is to generate excess steam. Spent pulp (sulphite) liquor will run about 6000 Btu per gallon and, therefore, is an excellent fuel/feedwater for the Zimmerman Process. Another excellent effluent for the process is the waste from dairy products processors, which runs about 7 per cent "fuel".

The implications are very significant: The two industries most plagued by surface water pollution complaints stand to benefit the most *economically* from the new process. The solution of their pollution problem comes as an extra benefit, and the reduction of other effluent treatment costs is yet another. In the case of the pulp industry, chemical recovery of inorganic salts left over from the combustion of spent liquors represents another significant dollar saving.

Technical Report Due

Release of complete technical details of the process has been complicated by the many pending patent applications. It is expected, however, that a great deal more information will be made known in the near future. When it is, POWER ENGINEERING will bring it to you.

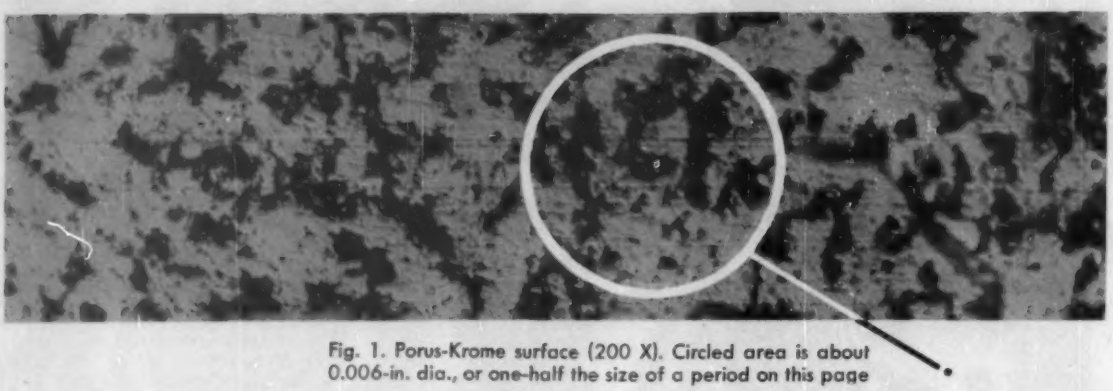


Fig. 1. Porus-Krome surface (200 X). Circled area is about 0.006-in. dia., or one-half the size of a period on this page

NOW YOU CAN RENEW WORN CYLINDERS WITH CHROMIUM

NEARLY EVERYONE is more or less familiar with the idea of plating frictional bearing surfaces with chrome to obtain a hard, long-wearing finish. Nevertheless, many believe that even though chrome provides an excellent wearing surface, "it is impossible to lubricate," and is therefore unsuitable for a bearing surface subject to sliding friction.

In general, this is true; a machined surface that is simply chrome-plated by the usual methods is not desirable, for example, on a diesel cylinder wall. There is now available, however, a method of functional chrome plating that has proven to be practically ideal for such service. This method, called "Porus-Krome" by the Van der Horst Corporation of America who developed it, is a patented process which provides a finished surface of chromium that is hard, long-wearing, dimensionally accurate, and "tailor-made" for lubrication purposes.

The essence of this process — a feature that makes the chromium plating practical — is a controlled surface porosity achieved by an electro-chemical etching of the deposited chromium; this results in a multitude of minute pores which form oil pockets over the entire surface. The appearance and extent of the pores in a finished Porus-Krome surface are shown in Figs. 1 and 2.

Electro-deposited chromium has a number of advantages as a cylinder-lining material. It is the hardest metal that can be used for this purpose, and it retains its hardness well above the range of normal cylinder wall operating temperatures. From a frictional point of view, chromium has one of the lowest coefficients of friction of any of the generally-used structural metals. Its corrosion resistance is very high, and this is an important contributor to the low wear rate of chromium in internal combustion engines, where corrosion is a problem of major importance. Furthermore, chromium has high heat conductivity.

These factors, of course, have been well known for some time, but it was not until Van der Horst developed the *porous* chromium finish that a method was found which permitted the surface to become wetted with oil, a most important factor in cylinder operation.

In the Porus-Krome method of plating, two types of surface finish may be obtained — depending on the controls exercised during the process. The first type, from which the process gets its name, is porous; the other type of finish is the channel type, shown in Fig. 3. The channel type is used most often in aircraft piston engines and is approved by the CAA.

The Van der Horst process was first introduced into the United States in the early 1940's, when it was used by the Navy for renewing the main engine cylinders of the salvaged submarine *Squalus*, which had gone down off Portsmouth, N. H., a year before. Impressed by the performance and record of the salvaged engines, the Navy made Porus-Krome plating a specification for later submarine diesels. Since that time, the process has been widely adopted by commercial engine builders and operators.

To the engine operator, one of the chief advantages of Porus-Krome plating lies in its ability to reclaim worn or scored cylinder liners. Liners renewed by this process are brought back to original dimensions, thus obviating the necessity of going to oversizes for replacement rings and pistons after overhaul. In addition, the plated liner will be longer-lived than an original unplated liner. The company has evidence to indicate that plated liners can provide up to at least three times longer service life than will the same type of liner that is not plated. Under circumstances in which abnormal wear occurs because of unusual abrasive or corrosive conditions, this plating may increase cylinder life five times.

What about cost? Usually, the company states, the cost of renewing a cylinder liner for an average diesel will be less than that for a new liner. (See accompanying table.)

Although it is not claimed that renewal of all types of cylinders with Porus-Krome is invariably cheaper than the replacement cost of new liners, Van der Horst points out that, in any case, the added service life obtained with the plating will render the process most economical in the long run. One aspect of economy to be expected — aside from longer life — is a decrease in oil consumption, a notable feature of Porus-Kromed liners. Another advantage, related to longer service life, is the reduction of

Table of representative costs of reclaiming cylinders with Porus-Krome process

Manufacturer	Engine Type (cycle)	Bore and Stroke of cylinder	New Cost	Reclamation Cost
A	4	12¾ by 15½	$ 225.00	$ 165.00
B	2	17 by 17	1100.00	598.00
C	2	8⅛ by 10	590.00	275.00
D	2	21½ by 29	2500.00	1900.00
E	4	16 by 24	726.00	478.00

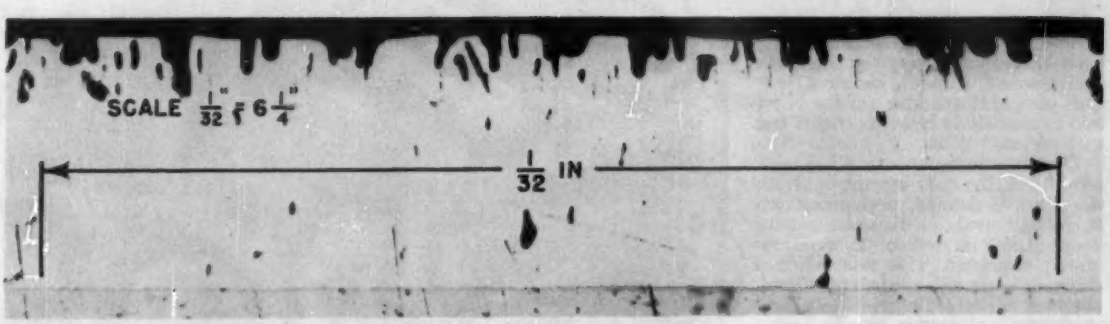


Fig. 2. Profile of Porus-Krome surface magnified 200 times. Dimension shows scale of enlargement; note pockets for oil

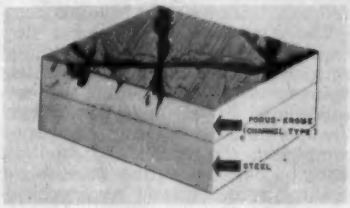


Fig. 3. Channel type Porus-Krome finish, preferred for use in aircraft engine cylinders, produced by plating control

down-time for overhaul and repair.

A broad range of cylinder sizes can be handled at the company's plants. Cylinders varying from a bore of slightly more than one inch up to as large as 29 inches have been processed in the past. The recent acquisition of the largest vertical hone in the country (Fig. 4) enables the company to handle cylinders with inside diameters up to 32 in. and lengths up to 9 ft–10 in.

When a worn cylinder liner is received at the plant, it is first thoroughly degreased and cleaned with solvent and caustic solution. It may then be heated in an oven to several hundred degrees to soak out any remaining oil or moisture. At this point, the cylinder is measured for out-of-roundness, waviness, and linearity. If badly worn, it goes to the boring mill to be bored to a true cylinder.

The maximum practical thickness to which chromium can be deposited is about 0.015 in. on a side. If the bored-out cylinder diameter exceeds the original specification diameter by more than 0.30 in., it is necessary to reduce the bore to practical chrome-plating limits by adding metal. This is done with another plating operation, also a patented process, which deposits electrolytic iron, called "Vanderloy," on the cylinder walls. There is no practical limit to the thickness to which Vanderloy can be applied.

In building up the bore with Vanderloy, the cylinder is masked off with wax to prevent plating elsewhere than in the bore. The liner is placed in a special figure and a soluble steel anode is centered exactly and concentrically in the bored hole. This assembly is lowered into a reverse-current etching bath which completes the bore cleaning and gives the base metal a "tooth."

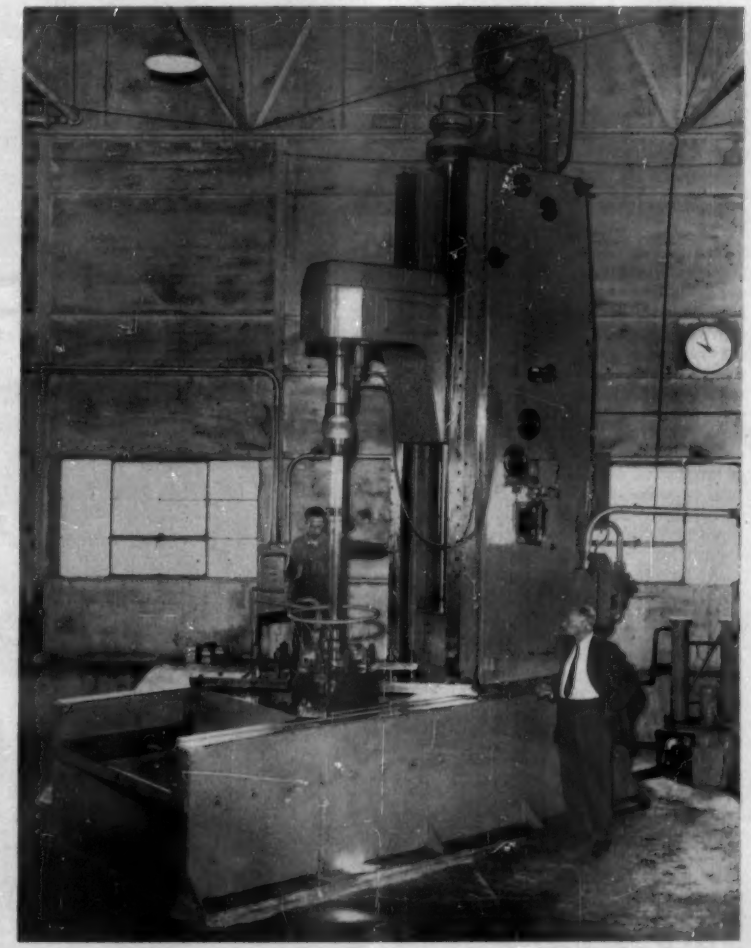


Fig. 4. Largest vertical hone in the country is used by Van der Horst to finish cylinders up to 118-in. long. Chromed surfaces are always honed to final diameter

From the etching bath, the entire assembly goes to the actual plating bath where, due to very rigid controls over anode alignment, bath content, and temperature, the thickness of iron deposition can be regulated within close limits.

When the iron deposition has been completed, the liner is removed from the fixture, cleaned, and measured. It is then honed to a diameter usually about 0.006 in. under the final required diameter. This allows for a chromium deposit of about 0.001 in. per inch of bore diameter. (Decorative chrome plating is usually deposited to a thickness of 0.00002 in.)

The chrome plating process also begins with a reverse-current etching bath. Another fixture is used which insures absolute alignment of the lead anode used in this operation. When the preliminary etching has been completed, the fixture and liner go into the chrome plating bath. Here again, careful controls are exercised over the plating operation. As in the Vanderloy process, the time element is the key to the thickness of the chrome deposit.

How Process Differs

When the chrome plating cycle has been completed, the deposit of metal on the cylinder wall is dense, and it is the next step in the operation that characterizes Porus-Krome.

As in all applications of dense chromium plate, the surface of the plated metal contains many fine "stress checks." These checks are minute and can be detected only under a microscope. By returning the cylinder to the original chrome etching bath and applying a reversed current so plating tends to reverse, chromium is removed from the cylinder wall. However, this removal of metal does not take place to any extent circumferentially; rather, metal is removed from the stress checks on the surface, thus tending to enlarge the checks or pores and so produce the desired porosity. At the same time, this action appears to relieve the chromium surface of stress — in a sort of normalizing process.

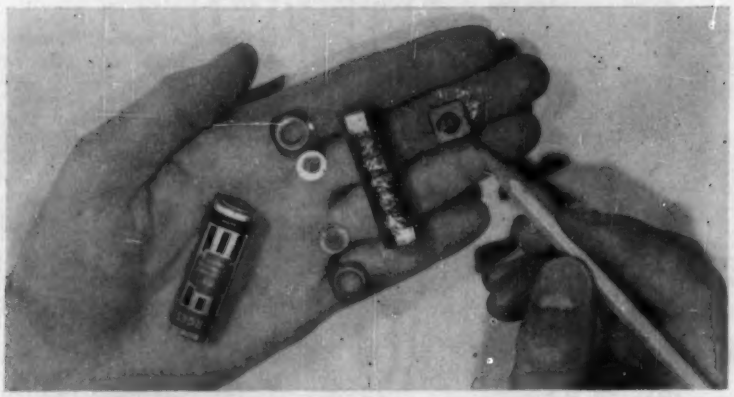
At this point in the operations, the cylinder is ready for the final honing to size. The final hone not only brings the cylinder bore to the required geometry, but also controls the surface finish as regards the extent and character of the porosity.

Users of this reclamation process are many, including such railroads as the New York Central, Pennsylvania, Union Pacific, and 90-odd others. Half-dozen petroleum companies have utilized it, as have a number of manufacturers such as General Electric, Blaw-Knox, etc. At least four of the largest engine builders use it as a manufacturing process in new engines.

The process is applicable also to compressor cylinders, steam cylinders, and a variety of other bearing surfaces subject to hard wear.

Fig. 5. This 21½-in. diesel cylinder, worn 0.250-in. oversize, was reclaimed with Vanderloy and Porus-Krome. Cylinder is in plating fixture, anode at right

Fig. 6. Some of various cylinder types that have been reclaimed by Porus-Krome



Pencil pointing to new "wafer-cell" shows its tiny size. Cells are made entirely by machine. Batteries are then made by stacking these cells in an aluminum tube

New Dry Cell Made Entirely by Machine

MAJOR STEP TOWARD the application of automation to the manufacture of dry batteries has been achieved by the Burgess Battery Company with the development of a new type of cell which makes possible a 30 per cent increase in battery power and life, eliminates traditional hand operations from cell manufacturing, and greatly boosts cell production levels.

New cell consists of a sandwich of artificial manganese dioxide mix between tiny discs of flat zinc and carbon electrodes. The old carbon rod of round cell batteries has been supplanted by a small piece of conductive carbon, and the whole sandwich is swiftly machine-wrapped in an airtight pliofilm envelope and heat sealed.

Welded or soldered wire connections between cells are eliminated by the use of silver wax, or new conductive wax intercell connection developed by the company's engineers. A dab of silver wax on the positive and negative sides of the cell permits the cells to be connected in series merely by being stacked in a column, and a multiple cell battery results from the electrical contact established between cells by the wax in pressure contact. Rigid inter-cell connections are maintained, even under rough handling, since the silver wax yields and molds itself to any necessary configuration between the cells required to hold perfect electrical contact.

A completed cell is so small that it barely covers a person's fingertip; yet the cell develops so much power that a tiny 2-in. battery made from 13 cells in a single column develops 22½ volts. Multiple cell stacks give miniature high-voltage batteries for heavy duty electronic applications. The company's new U200 battery made from the new automatically manufactured cells, provides over 300 volts in less than 20 cu in. of space.

Special features of the new cell, on which four patents have just been granted, include elimination of leakage between cells, rugged yet highly conductive inter-cell connections, and the ability to age and test each cell individually before it is incorporated into completed batteries.

A typical battery made up of the new cells contains almost a third more electricity-producing mix than a conventional unit. The pliofilm cell envelope is only 1.5 thousandths of an inch thick enabling a maximum amount of the cell space to be occupied by energy-producing materials. Additional space is also saved by the use of super-thin Mylar, a new polyester film, as the insulating cell stack wrap instead of bulky paper tape widely used on conventional batteries. The Mylar-pliofilm laminate is used to heat-mold each cell into a permanent locked position to preserve the inter-cell connection. In addition, the transparency of the wrap permits maximum quality control since inspectors are able to look into each cell stack to ensure perfect stacking and molding.

Special production line machines have been designed and built to manufacture the cells, which can be made in a wide range of shapes and sizes. Raw materials for the cells are fed into the machines automatically from rolls or sheets, and the finished cells are turned out entirely by the machines. Cell stacks are then compressed into a leak-proof tube of drawn aluminum and see service in hearing aids, pocket radios and recording devices, Geiger counters, photoflash cameras, and various types of transistor circuit electronic instruments, while a larger version of the cell is encased in a steel leak-proof jacket for use as a power source for portable radios.

New Material: Low Temperature Tar

CHEMICAL INDUSTRY has a new raw material from which a long list of new and known products may evolve. This new material is a low-temperature tar derived from the carbonization of lignite at the Aluminum Company of America's plant near Rockdale, Texas. This process and the complete Rockdale power plant were described in article Lignite Fuels 240,000-kw Alcoa Plant at Rockdale, POWER ENGINEERING, June, 1954.

It is known that low-temperature lignite tar contains valuable chemical compounds, but their utilization for chemical purposes has to date not been economically practical because no commercial quantities have been available.

Research and utilization of lignite tar became possible when Alcoa placed in operation its new aluminum smelter in Rockdale. Here dried lignite and carbonized lignite are used for the first time in this country as a fuel for generation of power for the smelting of aluminum.

A prototype carbonizer and tar recovery unit has been built and will produce 16,000 gal of lignite tar a day when in continuous operation. A research and utilization program, based on this new and relatively unknown material, is co-sponsored by Alcoa and Texas Power & Light Co. Research on the tar is being conducted by Battelle Memorial Institute.

As results from this research are available, findings will be furnished to various companies now participating in the research and utilization program.

Lignite tar products not purchased by these participating companies will be made available to other firms. Samples of materials presently available and specifications on such materials may be obtained from Texas Power & Light Co., P. O. Box 6331, Dallas 22, Texas, marketing agent for Alcoa for this material.

New Diesel Generators to Raise Plant Capacity

TWO 4500-KW DIESEL GENERATORS, among the largest ever built for a diesel power plant, will be installed early in 1956 by Lea County Electric Coop., Lovington, New Mexico. The added 9000 kw will raise plant capacity from 12,030 to over 21,000 kw. The engines will be 6296 bhp, 240 rpm, 12 cylinder, 2 cycle units built by Nordberg. The generators, being built by Electric Machinery Mfg. Co., will be rated 5625 kva, 4500 kw, 240 rpm, 2400/4160 v. Electric Machinery will also supply two 600-hp scavenger compressor motors. Consulting engineers for the installation are the A. C. Kirkwood Co.

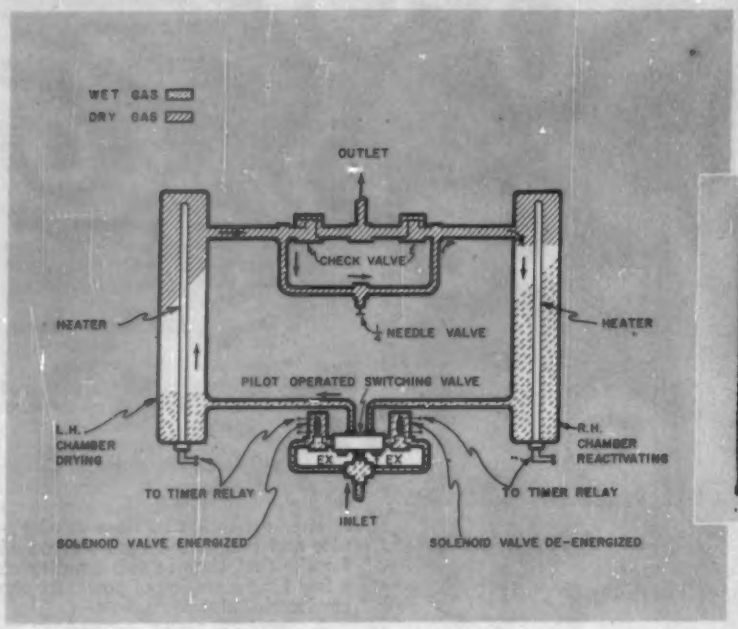


Fig. 1. (Left) Simplest form of adsorbent dehumidifier shows air cycle on which all operate, regardless of size

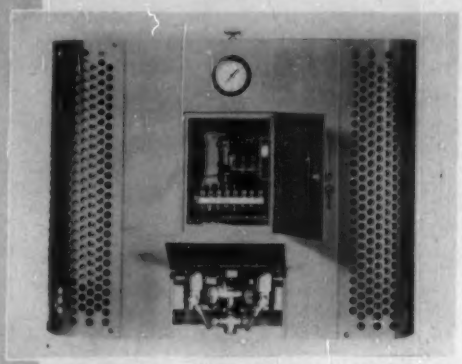


Fig. 2. (Above) Compact dryers such as this permit tailoring of pneumatic systems to trickle flows, or selectively treat air going to outdoor instruments

Dryers Stop Air Line Condensation and Freezing Without Tracers

Water vapor condenses in air lines when the temperature and dew point coincide. This can be stopped either by raising the air temperature or by dropping the dew point. The latter, accomplished by adsorption type dehumidifiers, can protect air to minus 40 F

By E. FEELEY*

DYNAMIC DEHUMIDIFIERS are containers packed with adsorbent materials (desiccants) to adsorb moisture from air that is passed over it. Figure 1 shows such a dryer in its simplest form. Periodically, the desiccant must be regenerated (dried out) because it has adsorbed all the water it can hold. For this reason, it has become the general practice to use two desiccant chambers, one of which operates while the other is being regenerated.

Several legitimate questions can be asked about these dryers. For example: Where do they fit into the average plant operation? Do they pay for themselves, or just add to the plant cost? If we got one, what type should we have?

To begin with, most plants utilize some form of compressed air. It is not uncommon to hear an engineer state flatly, "We have a dry climate so there is no moisture problem with our compressed air lines." But let us see what happens to "dry" air when it is compressed. Assume a 50 per cent relative humidity, which is rather dry for ambient air. Since the amount of water vapor that air can hold is directly proportional to the temperature and inversely proportional to the pressure, this air can be compressed only one atmosphere (with no temperature increase) before it becomes completely saturated. Thereafter, *any* drop in temperature will be accompanied by condensation of a proportional amount of moisture.

For this reason, air delivered from a plant compressor and aftercooler will be saturated (100 per cent relative humidity). After all, the aftercooler merely removes moisture *in excess* of the amount the air can contain at the aftercooler exit pressure and temperature. A further decrease in temperature (pressure constant) after the air leaves the aftercooler will start condensation in the compressed air lines.

One of the most important uses of dryers is their application to pneumatic instrument air lines. Successful operation of pneumatic instruments, which are controlling process and power equipment worth millions of dollars in some cases, is dependent on the delivery of "trouble-free" air to these instruments so that they may perform their control functions. The dryer completely eliminates any problem due to condensed water vapor even without steam or electric tracing. Lines can be run outdoors safely since a good dryer can drop the dew-point to less than −40 F. It is often more economical to install and operate dryers than tracers.

Powdered and granulated materials are often conveyed pneumatically, but only recently have engineers considered the advantages of drying the conveying air. Condensation is not as severe as it is with compressed air (conveying air is only slightly above atmospheric pressure), but some process materials are very seriously affected by slight condensation. Drying is especially valuable where the conveying air can be economically recirculated.

Many engineers have found it more economical to dry air where it is compressed than to install and maintain a large number of separators and traps along the distribution lines. The main advantage, however, is that the separators are only removing entrained water; the air may still be saturated with water vapor.

Recently I watched a process air hose in use in a California chemical plant. For the first three minutes the

*Sales Manager, Industrol Corporation, Roselle Park, New Jersey

hose looked more like a fire hose putting out a fire. During the next three minutes the hose put out a combination of air and water. A dryer could completely eliminate this problem — and it could be amortized in five years at a cost of less than 0.5 cent per 1000 scfm, including operating costs.

Dry air can also be used in such diverse applications as purging systems, paint spraying, providing moisture-free atmospheres for air-tight assemblies, wind tunnels, and pneumatic tools.

Nearly all dryers today are "package" type units. It is only necessary to connect the regeneration medium (generally steam or electricity) and tie in the air inlet and outlet lines. To suit individual needs, regeneration can be operated manually, semi-automatically or automatically. Regeneration cycles can vary from a few hours to days, depending on the service. Generally, regeneration time should be as short as possible but long enough to allow proper heating and cooling of the desiccant bed.

Units are available that hold as little as one pound of desiccant, or more than 1000 pounds, per chamber. Figuring the required size of a dryer should start with determination of the water load. To arrive at this figure, all you need is the number of standard cfm of air at a given pressure and temperature. With these three quantities it is easy to calculate the pounds of water to be removed per hour or per cycle. A rule of thumb, then, for figuring the desiccant is that about 10 pounds of desiccant should be provided for each pound of water removed between regenerations. For example, a dryer removing 10 pounds of water per hour and which is to be regenerated every six hours would require 600 pounds of desiccant per chamber. Shorter regeneration cycles would require less desiccant.

Specialized Dryers

About 90 per cent of the time these are the only factors that need be considered. In special situations where air velocities must be kept very high, however, this additional factor must be accommodated.

Many unique or highly specialized applications of dryers are being made by adding appropriate special features to standard units. To further increase the efficiency of both the special and the standard units, it is generally recommended that a prefilter be installed to remove entrained water and oil before the air contacts the charge.

Actually, there are many features that can be included with the standard dryer to make its operation more efficient and easier to service. Almost daily there are new jobs for specialized dryers. Nevertheless, each unit has the same basic function — to get better, more accurate trouble-free operation throughout every plant.

Fig. 1. Dust collectors trap, stow sawdust in tile silo adjacent boiler house

Fig. 2. Dust passes from silo to boiler chute via enclosed chain conveyor

Wood Waste Fuels This Modernized Plant

By R. W. CHILTON*

AT FEDERAL we manufacture post office equipment, postal lock boxes, and special wood furniture. The amount of sawdust waste resulting from furniture production was large, and with the prospective addition, since completed, of 10,000 square feet to our rough mill room, this amount was about to be greatly increased. The problem of collecting and utilizing this wood waste required an early solution.

One of the things we did was to modernize and enlarge our dust collection system, and to reposition the ducts so that they were efficiently placed over planers, shapers, mortising machines and allied equipment. These machines also were shifted from their original locations, which were established as they were acquired, and relocated in order to give us a straight line production flow. The ducts were then routed from the building, supported on a steel bridge over the railroad tracks behind the plant, to a large cyclone collector, placed on top of a 33-foot high, 14-foot diameter ceramic tile storage silo adjacent to the boiler house. The silo was selected because it provided economical and safe storage and permitted the sawdust entering it from the dust collection system to slide without caking or bridging.

Larger waste is collected in wheeled carts and periodically fed to a "hogger" which reduces the wood to chips which are easily carried via a separate air-duct to the same cyclone collector and silo that handles the sawdust and shavings.

To guard against any spontaneous combustion or explosion, the silo was provided with two overhead non-freezing sprinklers and with several low-inertia hinged panels.

The remainder of the combined dust collection — heating system installation, including the transfer of sawdust from the silo to the boiler and the selection and installation of boiler equipment that would best utilize the sawdust fuel, was handled by the Applied Engineering Co.

They decided they could best handle the stack discharge, waste conveying and firing problems by: 1) conveying wood waste from the storage silo to the boiler automatically via a chain conveyor, 2) automatically controlling the amount of fuel fed into the boiler in order to maintain steady combustion with fuel burning in suspension, 3) controlling the air for combustion by means of a forced draft fan together with special structural design of the boiler fire box to reduce gas velocity and minimize fly ash, and 4) equipping the system with automatic unifying controls to interlock the feed conveyor, burner, air volume, turbulence and feed water controls into a single functioning unit.

The mechanical conveyor they installed is an endless chain enclosed completely with heavy gauge sheet metal. The chain is driven by means of an electrically driven gear mechanism, the speed being automatically controlled to maintain a desired combustion level. The fuel from the conveyor moves via a chute into a high velocity air stream and is carried into the fire box and distributed over the entire grate area. Undergrate air keeps the dust in suspension throughout combustion and air injected through a hollow bridgewall increases turbulence. This works for both dry and green (or wet) wood wastes.

The installation, now in operation, has proved most successful and has eliminated a fuel bill amounting to hundreds of dollars annually.

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Marine Power Plants Do Well Ashore

CAN A SEA-GOING power plant ever find a useful berth ashore? In spite of opinions to the contrary, many engineers who have adapted marine power plants to industrial applications give an emphatic "Yes!" to the question and back up their statements with figures to prove it.

The fact is, given the proper circumstances, a marine power plant or steam generator may provide the only satisfactory answer to a vexing economic problem. Usually, such a problem is one that involves the provision of needed additional capacity in a hurry without large capital investment, and, at the same time, assumes the availability of a suitable marine unit under surplus or distress conditions.

Such units, of course, are not catalog items to be obtained by filling in an order blank, but they are occasionally advertised for sale and it is always possible to canvass shipyards and Navy installations for leads. The boiler manufacturers themselves are another likely source of information.

When a suitable power plant has been located, and installation plans made, it will generally be necessary to consider the controls and instrumentation required on the unit. Because of the relatively large operating crews aboard ship, marine power plants lack much of the control and indicating equipment that is standard on conventional stationary plants. However, control equipment manufacturers and suppliers will make recommendations and can easily furnish the necessary hardware.

A question often asked is, "What kind of performance can I expect from a 'lash-up' like that?" The answer is — if the equipment has been carefully selected — excellent. A large number of such installations have been made with results that exceeded expectations. A few of the power problems that have been solved by use of properly applied marine units are given here. These data are from papers delivered before the American Society of Mechanical Engineers (see list of references).

In 1948, an International Paper Co. plant in Panama City, Fla., was faced with the necessity of providing approximately 3000 kw of additional capacity to tide them over the interim between installation of added manufacturing facilities and an extension of the existing power plant. (Ref. 1.)

Inquiry revealed that a tanker was being reconditioned and repowered in a nearby shipyard; the original main propulsion power plant, consisting of a 4925-kva turbo-electric drive, boilers, and auxiliaries, was for sale and capacity, steam pressure, and voltage suited their needs precisely. The plant was purchased, and after three months of design and construction, went into operation.

Major equipment consisted of the following:

One 4925-kva turbine-generator, 3600 rpm, 60 cycles, 2300 v, unity power factor,
Two 32,000-lb/hr steam generators with pressurized furnace; steam outlet conditions, 450 psig, 730 FTT,
One 8300-sq-ft surface condenser with condensate pump, air ejector, etc.,
One 70,000-lb/hr spray-type deaerating feedwater heater,
Two 200-gpm turbine-driven boiler feed pumps.

With minor exceptions, equipment layout was the same as that aboard ship. The generator was not synchronized with the main plant, but arrangements were made to shift its load back to the main plant in the event of an emergency shut-down.

The steam system was independent of the main plant, except for a low-pressure line from the main boilers to furnish steam for heating boiler feedwater. Condensate from this steam provided the make-up for losses in blowdown and leakage. A flow diagram of the steam and condensate system is shown in Fig. 1.

After the initial start-up, various operating difficulties arose due to the conditions of operation which differed from original design considerations; in every case, however, these difficulties were simply overcome and plant operation has met, or exceeded, expectations. It is now the opinion that service from this plant is as reliable as that from any remote utility system. Data on average operating performance is shown in the Table. Heat balances are shown in Fig. 2.

An interesting result of the company's experience with the installation was the enthusiasm developed for certain of the marine plant's features which differed from conventional land practice. In particular, the pressurized boiler furnace was a highly acceptable feature, as is the practice of enclosing the air cooler in the generator housing instead of providing a duct-work system below the floor. It is generally agreed that experience with this plant has been beneficial to both operators and designers.

Another case in which marine power units came to the rescue is the installation of three marine boilers at the Salt River (Arizona) Power District's Cross Cut Steam Plant in July, 1947. (Ref. 2.) These boilers became a permanent part of the station's steam-generating capacity. Their record of performance has been excellent, and only minor maintenance has been required even though abnormal increases in the system's load caused these boilers to be operated beyond their rated capacity until late in 1953, when additional generating facilities became available.

	Design normal	Design peak	Actual
Steam (M lb/hr)	32.06	44.44	249
Type of fuel	oil	oil	oil
Excess air leaving (%)	15–20	15–20	23
Fuel (M lb/hr)	2.16	3.13	1.83
Steam pressure (psig)	450	450	434
Temperature (F)			
Steam	730	764	744
Feedwater	300	300	237
Air to air heater			104
Air from air heater			272
Air to burner wind box			309
Flue gas to air heater			513
Flue gas leaving boiler	340	380	315
Oil to burners			203
Oil Pressure (psig)			157
Total draft loss (in. H_2O)	3.7	7.8	
Lb steam/lb oil	14.45	14.2	13.6
Efficiency (%)	88.0	85.8	86.0

When it became imperative to acquire immediate additional steam capacity, the only suitable boilers available to the District's system were those built originally for installation on Maritime Commission VC2-S-AP3 turbine-driven vessels. These were B & W boilers of the single-

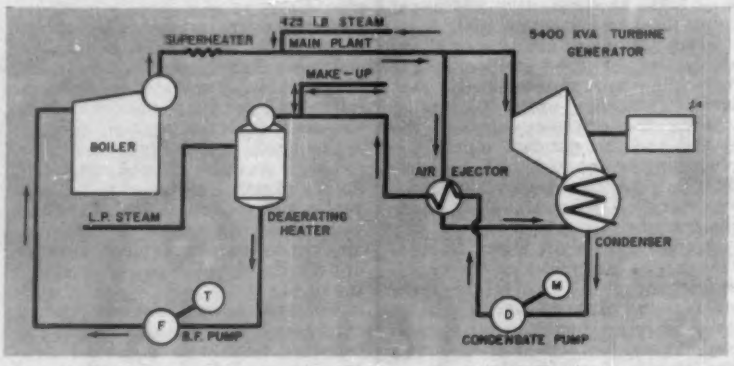

Fig. 1. Flow diagram and steam system of marine power plant installed in pulp and paper manufacturing plant. 425-psi steam line from main plant added later

drum, sectional-header design, fitted with oil burners, inter-deck superheaters, economizers, and water-cooled sidewalls. The installation was completely out-door with no shelter for the equipment or the operators.

In 1948 the boilers were equipped to burn natural gas as well as oil. From the spring of 1949 through the summer of 1952, the boilers were operated continuously except during annual maintenance periods. Natural gas was burned except during rare interruptions when residual fuel was used.

Capacity of each boiler is rated at 34,000 lb of super-heated steam per hr, plus 3500 lb per hr of saturated steam. With a combined rated superheated steam capacity of 102,000 lb per hr, the three boilers were normally operated continuously at a load of 125,000 lb per hr — in addition to their saturated steam output, which is not metered. In emergencies, they have been operated at a combined load of 140,000 lb per hr for periods as long as 36 hours.

At present, these three marine boilers are supplying steam to a 7500-kw turbine generator. Operating conditions at a combined flow of 125,000 lb per hr are:

Drum pressure	445 psi
Superheater outlet pressure	420 psi
Steam temperature	750 F
Feed water to economizer	258 F
Exit gas temperature	375 F

It is the opinion at the plant that operation of the marine boilers is as satisfactory and reliable as any of the stationary steam-generating equipment presently operated by the District.

A somewhat similar experience with marine boilers is recorded by the Texas Division of The Champion Paper and Fibre Co. (Ref. 3.) In the post World War II period, the Texas Division increased its production capacity and required enlargement of its steam-supply facilities. Four B & W oil-fired, divided-furnace boilers, originally designed for Navy destroyers, were purchased as war surplus to meet this need.

For naval service, the boilers were rated at 122,500 lb of steam per hr at 565 psi and 850 F. Average designed heat release rate was 330,000 Btu per cu ft per hr. Before the boilers could be integrated into the plant steam system, considerable changes in the equipment were required.

Since Champion had a long-standing contract with the Houston Lighting & Power Co. for the purchase of superheated steam at 310 psi and 650 F, all their equipment has been designed around those steam conditions. Consequently, when the marine boilers were installed, they were rerated at 350-psi drum pressure and 310 psi, 750 F, at the superheater outlet; necessary relief-valve changes were made.

At the lower steam pressure, with decreased steam density, the reasonable allowable superheater pressure drop became the determining capacity factor. The rerated maximum steam flow is now approximately 65,000 lb per hr with a superheater pressure drop of 40 psi.

As natural gas was available in ready supply at a cost of less than 15 cents per million Btu, the oil burners were removed from the boilers and ring-type gas burners were fitted.

The final major modification was in instrumentation. Provided for boiler control were three-element feedwater control, two fuel-air ratio controllers, steam flow meter, feedwater flow meter, gas fuel flow meter, three-point temperature recorder, drum level recorder, and all necessary dampers, valves, safety devices, etc. The controls were designed and furnished by the Bailey Meter Co.

The four marine boilers at Champion have been a dependable and economical source of steam, it is claimed. The units were utilized 70 per cent of the time, but were 98 per cent available. Steam cost during 1954 was 25 cents per million Btu (28½ cents per 1000 lb of steam). Natural gas fuel cost approximately 13 cents per million Btu and the fuel cost represents 72 per cent of steam cost. Chargeable labor and supervision amounted to only 3 per cent of steam cost; maintenance accounted for about 1 per cent. The remaining 24 per cent represents power, depreciation, taxes, and overhead.

It is believed that three factors permit the dependable and economical operation of these marine units as stationary steam generators. These are: first, complete automatic combustion control; second, proper boiler water conditioning and control; and third, the inclusion of automatic safety equipment and the routine checking of that equipment to ensure correct operation when needed.

The three cases of successful application of marine power plants to stationary duty cited here are by no means unique, but these three are sufficiently well documented that facts and figures can be presented for critical evaluation.

Recital of these successes does not, of course, imply that all problems of increased steam or power demand can be solved by the use of marine power plants. It will be noticed that in each of the installations described there existed circumstances and conditions which were compatible with available marine equipment. Naturally, such compatibility must always exist if the application is to be satisfactory.

For example, the type and cost of available fuel is an important consideration. Marine boilers, being compact units by necessity, have closely-spaced boiler tubes; these tubes are difficult to clean, and use of a fuel that results in the need for frequent fireside cleaning will require an inordinate amount of time and labor.

Other things being equal, however, the point remains that, given the proper environment, marine power plants *can* do well ashore, and many engineers have proved it.

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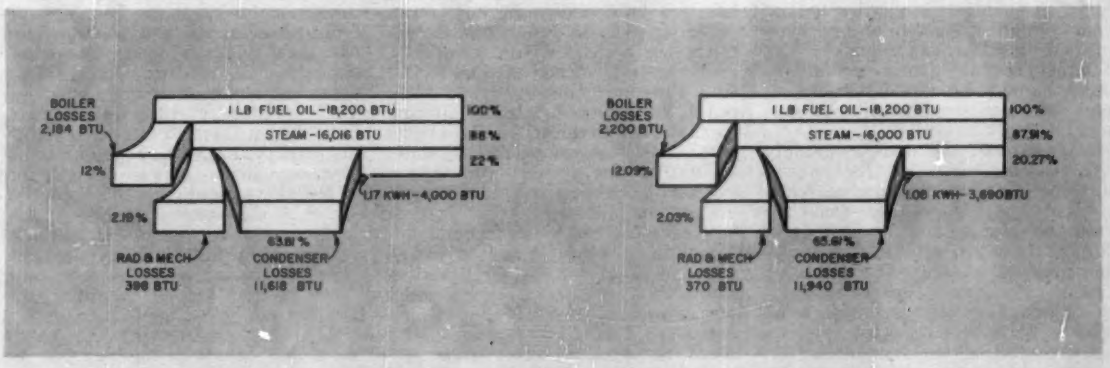


Fig. 2. Diagram at left shows design heat balance at 4615-kw load, heat rate 15,550 Btu/kwh; right, actual heat balance with 4135-kw load, heat rate 16,850 Btu/kwh. Higher fuel consumption in actual data due to cooling water limitations

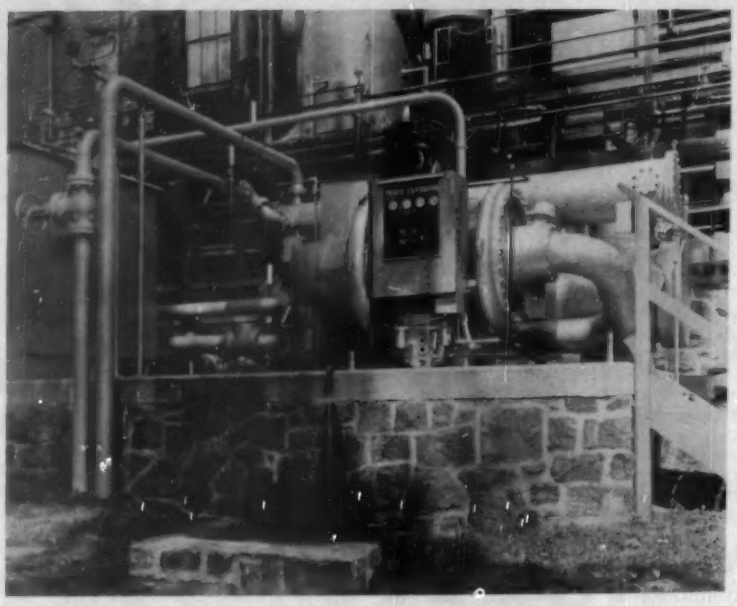
Outdoor Centrifugal Chillers That Need No Cover

CENTRIFUGAL water chillers are now available for outdoor installation without enclosures. Sizes for these units run from 50 to 800 tons capacity. They are set up for automatic operation and are hermetically sealed, both of which are essential to economic outdoor applications.

The purge unit, control panel, conduit boxes, and capacity control mechanism are weatherproofed and provided with electric heaters to prevent condensation. Even the insulation is weatherproofed and painted with a weather-resistant paint.

Though new buildings can be designed specifically to utilize these units, it is likely that their greatest application will be in existing buildings which require expanded facilities for comfort or process cooling. They can be tucked away on the roof, on the ground outside, or on some external framework which can be beefed up to support them. Nearly all plants have room somewhere for them.

There is nothing new about centrifugal chillers, but this added versatility should definitely increase their use.



Typical outdoor installation of the new chiller. Operation is automatic, but capacity control is mounted outdoors on the unit in weatherproof, heated panel

European Transformer Uses Cast Resin for Insulation, Container and Bushings

EUROPEAN DEPARTURE in transformer design — a dry type using cast resin for insulation and case — will dominate the field in Europe, H. H. Schwager, of the Schwager-Wood Corp., Portland, Ore., predicted during a recent AIEE session on transformers. He added that they had met the most rigid specifications since they were introduced in 1947.

"The new synthetic resin transformers," he said in a paper, Recent European Developments in Current and Potential Transformer Design, "have certain advantages. These are high mechanical strength against short circuit stresses in wound type current transformers, smaller size, complete sealing against dust and insects, elimination of fluid insulation and its consequent handling equipment and fire hazard.

"In general, the most commonly used casting resins are the epoxies also known as ethoxyline resins. When combined with a special hardener the resin sets under the application of heat without the necessity of applying pressure into castings which are free of void spaces. The casting hardens through a polymerization reaction and no volatile substances are set free during the hardening. Recently cold hardening resins have also been employed. The castings exhibit great mechanical strength and reasonable resistance to high temperatures. They are to a great extent resistant to atmospheric and chemical attack and possess very good dielectric properties and creepage strength. Physically the resin is transparent, of a reddish color, and completely nontoxic. The pure resin itself, however, is still relatively expensive. Added to this cost is the scrap cost due to misruns which is high in that any casting already hardened must be scrapped completely since it cannot be melted down and the resin used again, nor has the hardened resin any scrap value. To overcome these cost factors fillers are added to the resin. The resin can be stretched with up to 200 to 250 per cent filler by weight without altering or very slightly altering its basic mechanical and electrical properties. Finely powdered dry slate, talcum powdered dry slate, talcum powder, silica or similar substances are used as fillers.

"Since the cast resin is quite different in its physical characteristics from the usual transformer insulating materials a new style of transformer was developed which bears little resemblance to the now known instrument transformers. The greatest revolution in design has taken place in the lower voltage transformers intended for indoor use. This is in accordance with the usual European practice of placing all distribution transformers and stations indoors up to voltages of 60-kv. Consequently the indoor transformers were developed first."

Such resin insulated wound type current transformers in rated voltages of 10 through 60-kv are built in standard current ratings up to 600 amperes in all standard accuracy classes, he said. "One advantage of this type of design is immediately discernible in that no metal container or bushings are required in order to secure the active parts. The cast resin not only acts as the chief insulation of this transformer but also as its own container and bushing. Tests on these current transformers have shown them to have a remarkable ability to withstand short circuit stresses. Current surges in the order of 500 times rated current showed no signs of disturbance in the transformer and no visible vibration could be noticed during the test. Long-time overload tests with 150 per cent rated current did not overheat the transformer or cause any damage."

Mr. Schwager's paper was based on a year's study of the high voltage switchgear industry in Europe in 1953–54.

Selection and Care of Sewage Sludge Filter Blankets

By WARREN L. SHEDDEN

Warren Shedden has been charged with the responsibility of Filter Room operation at the Southwest Sewage Treatment Plant of the Sanitary District of Chicago for the past nine years. He was previously employed by Raymond Pulverizer Division of Combustion Engineering Co. and attended University of Illinois. In World War I he served in the Marine Corps; in the second World War, Army Service Forces

IN ANY SEWAGE disposal plant where sludge is dewatered to provide filter cake for the production of fertilizer, the filter room is the heart of the plant. Efficient filter room operation and production in turn depend largely on the selection, installation, and care of the filter cloths, or blankets, which cover the filter drums. These blankets serve the purpose of removing most of the liquid from the sludge and thus produce a thin, moist cake of the retained solids. The cake is further dried and treated to become ultimately a fine, granular organic material which can be incinerated or used as a fertilizer base.

At the Southwest Sewage Treatment Plant of the Sanitary District of Chicago, sludge resulting from the activated sludge process is filtered on vacuum filters, dried by flash dryers, and disposed of in bulk as a fertilizer base. The original plant design specified filtration, drying, and incineration of sludge from both the preliminary settling tanks and the activated sludge plant. However, after about seven months of operation, difficulties in the drying system caused by high grease and fat content of the preliminary sludge led to the disposal of this material by other available means.

Originally, 24 filters, 11½ ft in diameter by 16 ft long, were provided. They were arranged in eight lines of three filters each. Each line discharged to a rubber belt which carried the filter cake from the filters to a drying system. In 1940, after about a year of operation, an additional filter was added to each line. During 1953, three more filters were added to each of the original lines, and six new drying lines with seven

ACKNOWLEDGEMENT

Design and research on all phases of sludge filtering and disposal for the Sanitary District of Chicago is under the direction of Wm. A. Dundas, General Superintendent; W. R. Trinkhaus is Chief Engineer, H. P. Ramey, Acting Chief Engineer, Langdon Pearse, Sanitary Engineer, F. W. Mohlman, Director of Laboratories, and C. P. McLaughlin, Engineer of Mechanical Design. Phillip Furlong is Engineer of Maintenance and Operation. Operation of the West-Southwest Sewage Treatment Plant is under the direction of A. H. Goodman. Physical research and testing is under the direction of A. J. Beck, Senior Sanitary Chemist, and C. G. Poindexter, Asst. Sanitary Chemist. J. W. Wade, Senior Civil Engineer, is responsible for correlating results of operation with specifications.

Fig. 1. Some of the 98 vacuum filters housed in the Sludge Disposal Building at the Southwest Treatment Plant of the Chicago Sanitary District. Filter cake from these units goes to drying system

filters each were installed, bringing the total number of filters to 98. The new facilities were available for service by November, 1953.

Ferric chloride is used to condition the sludge, which is concentrated from about 0.8 per cent solids, as wasted from the final settling tanks, to between 1.2 to 2.0 per cent solids as delivered to the filter room. The pH range of the treated sludge is approximately 3.0 to 4.0, varying roughly with the volatile matter content of the sludge, and varies inversely with the quantity of ferric chloride required to condition the sludge properly. It is essential that the sludge be properly conditioned if the filter blankets are to produce the desired filter cake efficiently.

The capacity of the drying system is affected by the quantity and moisture content of the filter cake delivered to it. One of the most important factors in determining the quality of the filter cake going into the dryers is the performance of the filter blankets.

Fig. 2. California redwood staves are bolted to filter drum for mounting the plastic separator grids. Wooden staging shown in this photograph is temporary

Since the beginning of its operation, this plant has endeavored to obtain the best possible filter cloths for its use. Extensive studies have been made on the different kinds of available blanket materials, methods of installation, treatment, and maintenance.

The blankets on the original filters were napped wool twill of 12-oz per sq yd material. They were stretched tightly over 16-gage monel screening (½-in. mesh) which was fastened to wood grids that were nailed to the decking. Twelve-gage copper or copper alloy wire was wound spirally around the drums with two-inch spacing. The cake formed on the drums was removed by a heavy steel scraper blade welded to the apron and pulled tightly against the winding wires.

Maintenance with this type of cloth mounting was high, due to corrosion, wearing, breaking of the wires, and corrosion of the monel screening. Since monel screening for replacement was not then available, wood was substituted for the backing grids that provided drainage and support for the filter cloths. During World War II, restrictions on strategic metals also affected the supply of copper wire available and so experiments were begun with other methods of fastening the cloth to the separator strips on the drums.

This was first accomplished by grooving the separator strips and holding the cloth with nailed wood strips which forced the cloth into a tight fit in the groove. A shoulder cut into the backing around each end of the filter permitted similar end fastening of the cloth. The scraper blade set-up was altered so that it was held against the cloth only by a weighted bar at each side. Travel of the scraper

Fig. 3. Latest type of plastic filter grids in use on Chicago's vacuum filters. Grids are molded styrene, nailed to wood decking (see Fig. 2). Plastic forms are durable and resist clogging

was limited by set screws to ensure that it cleared the retaining strips at the panel separators. Somewhat later, the stiff steel scraper blade was replaced by an eight-inch strip of 22-gage stainless steel bolted to the apron so that it extended five inches. The set-screw adjusted floating arrangement was continued. The present scraper blades are of 16-gage stainless steel, which proves to have longer life, holds much better alignment, and exhibits less tendency to sharpen at the scraping edge.

Injection-molded polyvinyl chloride plastic panels are now used for backing grids, the ribs being vertical to the separator strips. The cloth is held in place by acid-resistant cord driven into the dovetail mortises cut in the separator strips. The ends of the panels are sealed by tightly drawn stainless steel ribbons nailed at intervals to prevent slipping.

In addition to the savings in materials, the panel fastening method now in use has resulted in reduction of time required to replace blankets and make repairs. Response of the blankets to water wash and detergent washing has been improved, and cleaning the backing at the time of cloth changing is much easier.

The change from wire winding to panel fastening of the filter cloth accelerated the blanket studies. With support every two inches by the original copper wire winding, ballooning of the blanket at the time of blow-back was greatly restricted, and this effect is desirable to permit good contact of the scraper blade with the filter cloth for proper cake removal. Abrasion effect was a much smaller factor. With the panel fastening, approximately 20 in. in one direction and 16 ft in the other of wet cloth was exposed to the blow-back air pressure. There was evidence of excessive elongation of the cloth in both directions. One remedy was reduction of the blow-back air pressure from 8 psi to about 2 or 3 psi; at the same time, cloth with lower elongation propensity was sought. The larger benefit came from an increase in the number of twists given the threads used and a slightly closer weave, resulting in a slightly heavier cloth.

In our studies of filter cloths it was the practice that no special care was given any cloth during the program, since it was necessary to discover their value for our use under ordinary operating conditions. At installation, the cloths are fitted snugly to the filter drum, with tension maintained as evenly as possible. A dark-colored woof thread woven into the cloth at about 4-ft intervals, as measured along the warp, greatly aids in aligning the blanket. The degree of tension required varies with the material and weave of the cloth to allow for differences in stretch while in service.

The blankets, as purchased, are about 16-in. longer and 6-in. wider than the actual measurements of the drum; this makes installation easier. The trimmings are used for patching blankets torn in operation. After installation, the blanket is given a detergent wash to thoroughly wet and flex the fibres. This detergent wash consists of two quarts of 60 per cent active triethanol amine alkylaryl sulphonate added to about 300 gal. of water in the filter pan, and the drum is rotated for about four hours with the agitator in operation. A foamy suds wash action results which cleans out most of the accumulation of solids, greases, and fungi which cause blanket blinding. A plain water rinse follows; the jet sprays mounted at the rear of the filter are used for this purpose.

During operation the cloths become loaded with sludge solids, grease, and iron oxide; in warm weather, fungus growths from the conditioned sludge blank off or blind areas of the blankets. Each filter is water washed after each 48-hour period of service. When this fails to clean it satisfactorily, detergent washing, as previously described, is used. This treatment will usually remove solids, grease, and fungus, but will not affect iron salt deposits.

If subsequent unsatisfactory cake pick-up indicates excessive iron oxide clogging, the cloth is washed with 18-degree Beaumé inhibited muriatic acid, which is dripped on the blanket at the top of the slowly revolving drum. Approximately twelve gallons of acid are applied, allowed to remain in the blanket for about eight hours, with the filter drum in motion. The filter is then sprayed with water for about an hour before it is returned to filter cake service. When less than 75 per cent of the area of the cloth fails to produce filter cake, it is marked for replacement.

A complete record is maintained for all blankets, showing such information as purchase contract, manufacturer, date received, blanket number, date installed, kind of material, weave, weight, pressure loss, wash and maintenance record, hours of service, date and reason for replacement. A sample of each blanket, as installed, is filed for possible future reference, and a second sample is sent to the laboratory for testing. There it is examined for conformity to specifications, including pressure loss. For our pupose, pressure loss is defined in inches of water at an air flow of 15 cu ft per minute per 0.1 sq ft of blan-

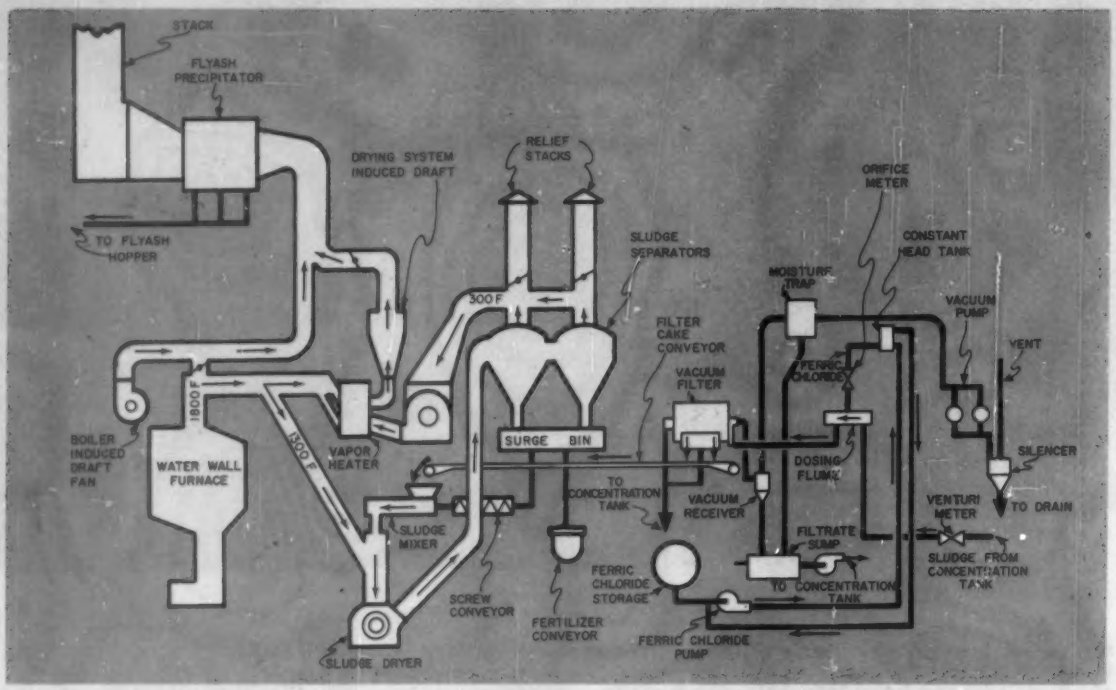


Fig. 4. Flow diagram of sludge treatment at Southwest plant. Fuel handling and sludge incineration details are omitted

ket area. This standard was adopted in place of the ASTM designation D 461–47, which defines permeability as the quantity of air pressure passed at 0.5 psi pressure loss, because it was found that the slope of the graph plotting pressure loss against air flow varied among the different types of materials.

Our apparatus consists of a source of low pressure air, a plenum chamber with a circular opening of 0.1 sq ft area, a zero to 2.0 in. inclined gage measuring to 0.01 inch, and an orifice flow meter. The cloth is clamped over the circular opening of the plenum chamber by means of a ring. The air flow and pressure are recorded for a sufficient number of settings to permit plotting a curve of the results. The pressure air flow curves for various cloths may then be compared, and correlated with operating data.

There are several desirable qualities in a filter cloth if it is to serve well under the severe conditions to which it is subjected. These are:

1. Pliability, toughness, snag and abrasion resistance, a minimum tendency to stretch. These qualities are necessary for satisfactory installation and long, efficient service;

2. Long nap. A nap of ½ in. or more helps to seal the blanket surface, pick up the proper amount of sludge and stand the wear of contact with the scraper blade;

3. Suitable pressure loss characteristics;

4. Resistance to chemicals used in the conditioning of the sludge, and acid washing of the blankets.

During the fifteen years of our operation the following materials have been used and studied: Cotton, untreated wool, treated wool, Vinyon, Nylon, 90% Nylon — 10% Saran, 25% Nylon — 75% wool, Dynel, 50% Dynel — 50% wool, Orlon, and Dacron.

The weight of materials has varied from 12 to 16 oz per sq yd. Some were napped, others not. The table rates the various cloths, except cotton, with respect to several factors considered of importance in their use under the conditions at this plant.

The following are brief comments

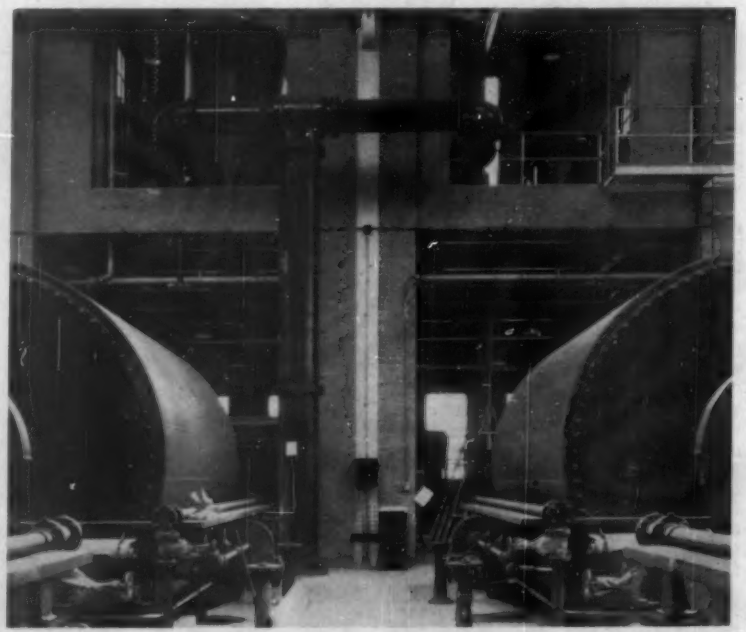


Fig. 5. Vacuum piping to moisture traps (see diagram in Fig. 4). Filter drum ends visible here will be opened up in manner similar to that shown in Fig. 2

Fig. 6 *(Left)*. Workmen installing a blanket on repaired filter. Fig. 7 *(Center)*. Blanket being fastened to filter drum with nylon cord caulked into channels of plastic separator grids. Fig. 8 *(Right)*. A filter blanket gets a detergent wash

on the various types of cloths used.

Cotton: The few cotton cloths used during the early years of our plant operation were too expensive, considering their short life and frequent wash requirements. None have been used since panel mounting was adopted.

Wool, untreated: Untreated wool twill blankets have been our general service filter medium throughout most of the years of operation. All have been long-napped, installed with the nap lying opposite the direction of the drum travel. All were satisfactorily pliable, and all continued to stretch through service. With the increasing weights, up to the 14- and 15-oz type, the characteristics of the blankets improved. The 12-oz blankets gave poor initial filter cake pick-up and required pre-service treatment and frequent in-service washings before desired filter cake delivery was obtained. The 16-oz type were too heavy, their installation was difficult, and the cake yield was low; they required too much care to be worthy of extensive study. The pressure loss for the wool cloths were: 12-oz, 0.31 to 0.38; 13-oz, 0.50 to 0.70; 14- to 15-oz 0.45 to 0.80. The pressure loss data on the 16-oz cloth are not available. The useful life for the 12, 13, 14, and 15-oz cloths averaged 1900, 2400, and 2700 hours, respectively; however, a few in each class did much better than the average of the blankets we tested.

Wool, treated: During warm weather fungus growths clog the interstices of the cloths and tend to fill up the backing grooves and drainage channels. In addition, filter blankets out of service for extended periods of time deteriorate as a result of microbial action. To combat this condition, washes of chlorine water, bromine water, pentachloraphenal solution and copper sulfate were used, but with very little improvement. Bromine water was very hazardous to the operating personnel. It was found possible to have the blankets treated at the mill with a permanent type bactericide either before or after weaving. While some apparent blocking of the interstices was occasionally in evidence, the over-all results were satisfactory, and the blanket life was increased. Pressure loss for these blankets ranged from 0.40 to 0.60 in., and their service life averaged 3300 hours. Elongation through service occurred, but was measurably lower than that with untreated wool cloths. Purchase contract specifications for these cloths used during the past several years are as follows:

"The weave to be two up and two down, straight twill, with a thread count of approximately thirty-one (31) end warp and twenty-five (25) end woof. The material to be all wool, weighing not less than 14½ oz per sq yd, exclusive of wool fat and bactericide; and woven in one continuous piece without seams and one side long napped. The amount of nap to be approved on sample submitted before fabrication. The wool to contain no oils, card fly, card strippings, card waste, or reused wool. Garnetted wool not to exceed 25 per cent. The warp and woof thread to be twisted 105 turns per ft, and the cloth to be finished in a manner to produce a minimum of stretch in the width. At approximately every 36 to 48 inches, as measured along the warp, a woof thread to be of a dark, distinctive, permanent dyed color will be inserted, to aid the mechanics while installing the cloth. The cloth to have sufficient permanent bactericide treatment to protect it throughout its useful

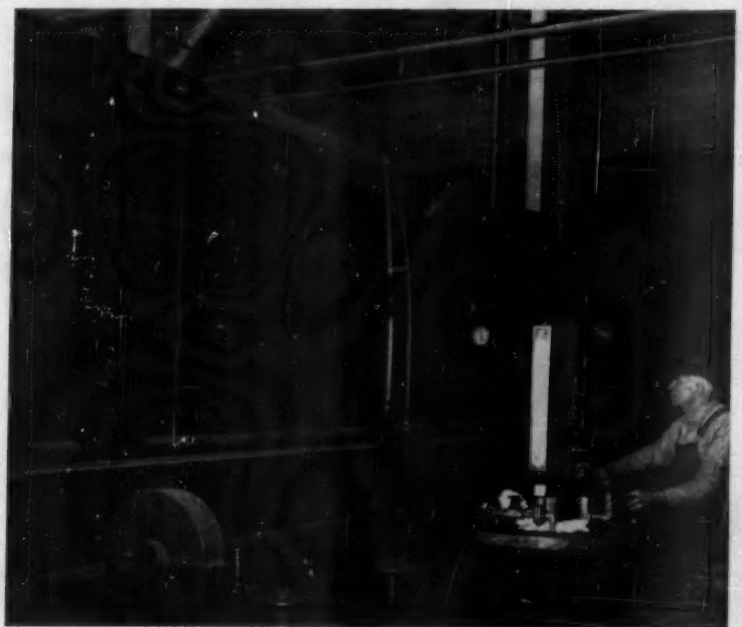


Fig. 9. Blankets clogged up with iron oxide are washed with inhibited muriatic acid dripped on slowly-revolving filter; approximately 12 gallons of acid are used

filter life. The treatment should add approximately 2½ per cent to the weight of the untreated cloth."

Vinyon: The Vinyon cloths used were not satisfactory, partly because of the type of weave, which presented installation problems and in-service stretching, and partly, of more serious consequence, its poor resistance to acid washing. These cloths were removed after an average of about 1000 hours of filter cake service.

Nylon: Highly variable problems and results were obtained with Nylon cloths; some had nap, others had to be napped with wire brushes One or two gave several thousand hours of satisfactory service and stood washing with 17½ per cent muriatic acid. Others deteriorated or glazed when washed with 5 to 7½ per cent muriatic acid, and the response of most to detergent washing was only fair. The glazing action appeared to be partial solution of the fibre with re-precipitation, resulting in a badly clogged cloth with a glazed surface. The material is durable and abrasion resistant, with very little dry stretch, but many showed excessive stretch while in service. However, testing is being continued on blankets in the 0.80- to 1.20-in. pressure-loss range. It is because of the wide range of results obtained from this material that we have been unable to establish a set program for wash and acid treating with any degree of assurance that the blanket will be serviceable after treatment.

Nylon, 90%; Saran, 10%: This combination of cloth in appearance resembled the 100 per cent Nylon, but because of the Saran content became brittle in use, requiring almost daily repairing. It was stiff and bulky, difficult to install. Its reaction to acid washing was similar to that of the 100 per cent Nylon cloths. The pressure loss was 0.74 inches.

Nylon, 25%; wool, 75%: This combination of materials is similar to wool in appearance, handling and service, but because of the Nylon content it had poor resistance to acid washing. It showed excessive elongation. The pressure loss was 0.62 inches.

Dynel, 50%; wool, 50%: This combination was rather bulky, but pliable; pressure loss was 0.90 inches. It withstood scraper abrasion well and responded to all types of treatment, but stretched in service as badly as 100 per cent wool cloths. It was quite satisfactory.

Orlon, 100%: This material was very soft and pliable; in appearance, it resembled Nylon. The pressure loss was 1.70 inches. It delivered a desirable filter cake but blinded out easily. The poor acid resistance of the cloth, and its poor response to detergent washing, limited its useful filter life to about 1000 hr, and its over-all use to about 2200 hr. This material, like Nylon, deteriorated or glazed when acid washed.

Dynel, 100%: Our studies have included one Dynel blanket with a pressure loss of 1.75 inches, and three in the range of 0.31 to 0.45 inches. The denser cloth was bulky and stiff, difficult to install. The others, which were more loosely woven, were softer and more pliable and of satisfactory consistency: however, none gave outstanding performance. There was very little in-service stretch, and they were responsive to acid and detergent washings, but were not as resistant to scraper abrasion as was desired.

Dacron, 100%: (Polyester fibre) This material is tough, strong, pliable, abrasion resistant, and dimensionally stable. It is acid resistant, and seems to be water repellent and rot resistant. We have 24 100 per cent Dacron filter cloths in service, and the above qualities are outstandingly noticeable in each case. The pressure loss of the Dacron blankets ranges from 0.50 to 1.61 inches. The material naps to our satisfaction and there is practically no in-service stretch. The material responds very well to all types of wash treatment.

Conclusions

It appears at present that these cloths are generally most satisfactory for our use, and will be adopted as our general service filter cloth. They rate high in all respects, and their toughness and durability is outstanding. One cloth is in excellent condition after over 11,000 hours of filter cake service; another has had over 7,000 hours and several more over 4,000 hours. None have been patched or repaired in any way, and all continue to give satisfactory filter cake production. None of the cloths are showing signs of abrasion wear or deterioration from decay. It is expected that many of the cloths will duplicate or better the outstanding performance of the original test blanket. The use of Dacron cloths in our plant, with 98 filters in service, will greatly improve productive operations and reduce blanket maintenance costs.

This table summarizes significant data compiled from a study of various types of filter cloth material over a period of years

Material	Wool 12 oz	Wool 13 oz	Wool 14–15 oz	Wool 16 oz	Wool, Treated 14–15 oz	Vinyon	Nylon 100%	Nylon 90% Saran 10%	Nylon 25% Wool 75%	Dynel 50% Wool 50%	Orlon 100%	Dynel 100%	Dacron 100%
Installation	Difficult	Difficult	Easy	Difficult	Easy	Very difficult	Very difficult	Very difficult	Easy	Easy	Difficult	Difficult	Easy
Initial Cake Pick-Up	Poor	Fair	Very good	Fair	Very good	Fair	Fair	Fair	Good	Good	Fair	Poor	Very good
Cake Production	Fair	Fair	Very good	Fair	Very good	Fair	Fair	Fair	Fair	Good	Good	Good	Very good
Elongation Tendency	Excessive	Excessive	High	High	Some, Varied	Excessive	High	High	Some	Some	Some	Some	None
Response to Water Wash	Good	Good	Good	Good	Very good	Fair	Fair	Fair	Good	Good	Good	Good	Very good
Response to Detergent Wash	Good	Good	Good	Good	Very good	Poor	Fair	Fair	Good	Good	Fair	Good	Very good
Response to Acid Wash	Good	Good	Good	Good	Very good	Poor	Very poor	Poor	Poor	Good	Poor	Good	Very good
Resistance to Scraper Abrasion	Poor	Fair	Good	Good	Good	Poor	Good	Good	Good	Good	Fair	Fair	Very good
Useful Life (Approx. Hrs)	1900	2400	2700	1500	3300	1000	800 to 7600	3000	3300	3700	2000	Over 4000	Over 11,000
Economic Rating	—	—	4	—	3	—	—	—	—	—	—	2	1

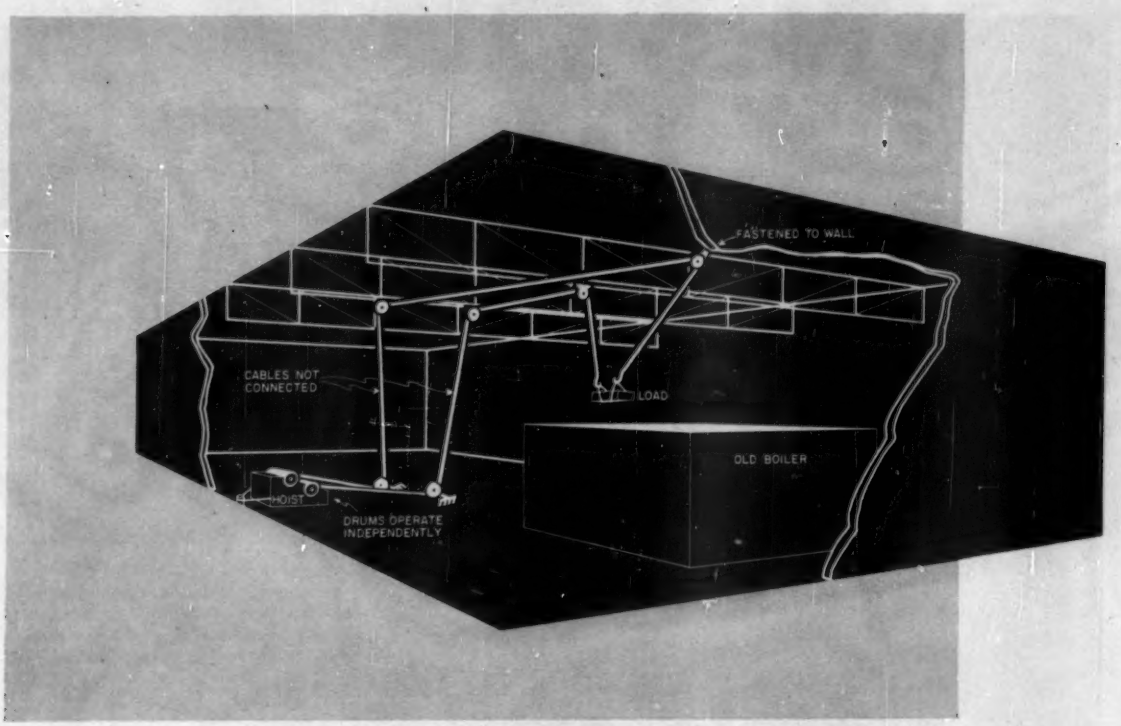


Fig. 1. Sketch shows location of hoist, floor-mounted blocks, overhead blocks. Always check structure strength

Old Boilers Dismantled in Tight Spot With Two-Drum Hoist, No Crane

When the time came to remove the old boilers and make room for the new, it had to be done without cranes. The engineer utilized some old cargo storage tricks, a hoist and six snatch blocks on this job

Fig. 2. Double-drum hoist was anchored to wall then braced against slipping

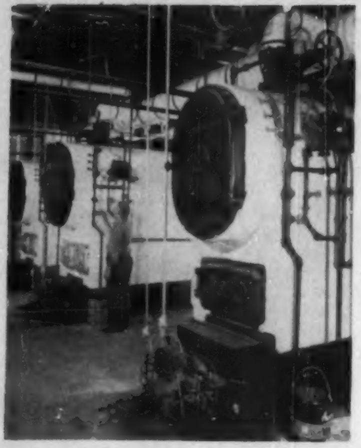
AMERICAN Hoist and Derrick Co. had occasion to use some of their own equipment recently when their old boilers were removed. No overhead crane had been provided in the boiler house so the dismantling could not be done conventionally.

Utilizing some maritime tricks, the engineer rigged a two-drum hoist (Fig. 2) and six snatch blocks to provide both vertical and lateral movement of the load. The hoist was anchored to a building wall and the snatch blocks located as in Fig. 1.

As each part was cut loose from the boiler, it was raised and swung to one side, then lowered to the floor where lift trucks carted it away. To lift, both drums retrieved cable. To swing the load, one retrieved while the other paid out. To lower, both cables were paid out.

Three drums 21 ft long by 36 in. in diameter were removed intact by this method. Each weighed nearly 4 tons. The fourth drum was cut up and removed in pieces.

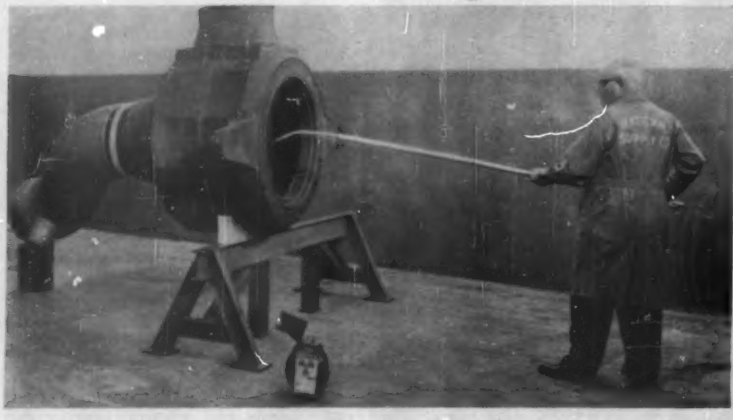
The old boiler was removed without trouble and without tearing out a wall. Unfortunately, the wall had to come out anyway when the new boilers were installed.



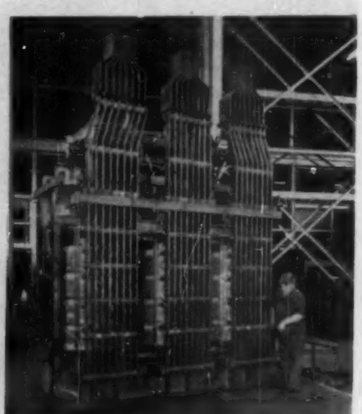
(Above) A York, Pa. school added on new space, but there was no room for extra boiler to heat it. Problem was solved by converting to oil and putting York-fired Pacific boiler in coal bin

(Left) Wide-angle atomic radiation detector, developed by GE at Hanford installation, gives better indication of total exposure of workers to radiation. This permits use of lower safety factors in figuring permissible work time without reducing safety; adds work time

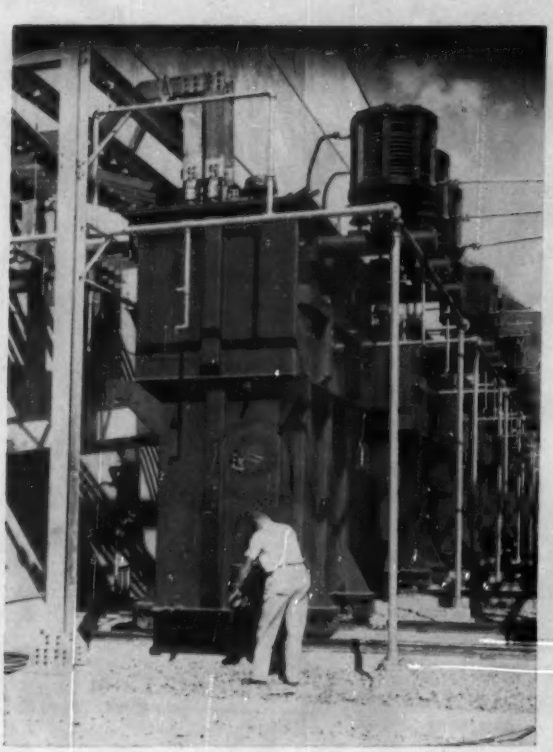
News Reel



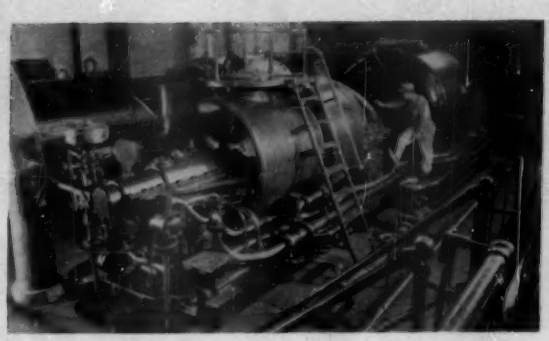
Cobalt-60 radiation source being placed in position for weld inspection. Film is stripped over weld with adhesive tape (left) and tiny cartridge is put inside. Flaws show when film is developed. Lead storage container for source on floor



Insides of a 27,000-amp arc furnace transformer for Atlantic Steel (Atlanta) gets check before being "canned" at GE

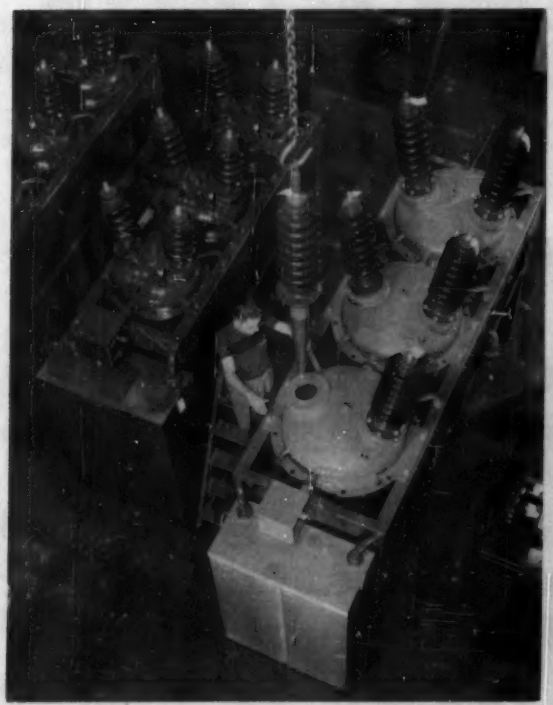


First water-cooled rectifier transformers cost less, weigh less, and take up less room at Anaconda's Columbia Falls aluminum plant. Westinghouse furnished the 10,200-kva units



Retiring after 47 honorable years, this 3250-kw, 1800-rpm Allis-Chalmers turbine boasts a list of replacements filling less than half a repair index card. Virginia E & P owned it

Marconi bust is unveiled for the AIEE by Mrs. Paresce, Marconi's daughter. From left, sculptor Montana, Mrs. Paresce, Pres. Hooven (AIEE), G. Marconi, and V. Ivella



Westinghouse equips its 250th circuit breaker with standard ASA bushings since the new standard was announced in 1954. That standard similar to design used since 1941

Rockland P & L's Pres. Charles Hulswit accepts bronze "Oscar" from *Financial World's* Weston Smith for best 1954 annual report in its class of electric utilities, 2nd best all

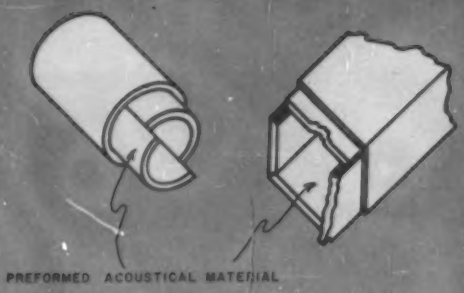


Fig. 1. Preformed acoustical pipe material for low velocities without impact

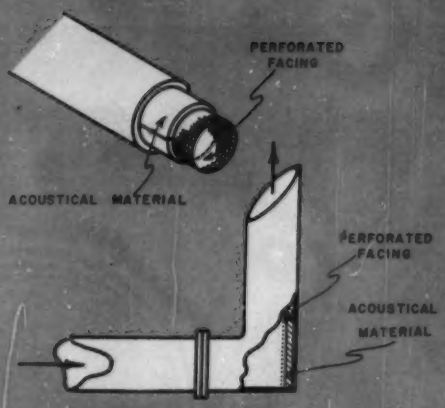


Fig. 2. Perforated facings prevent impact damage when velocities are high

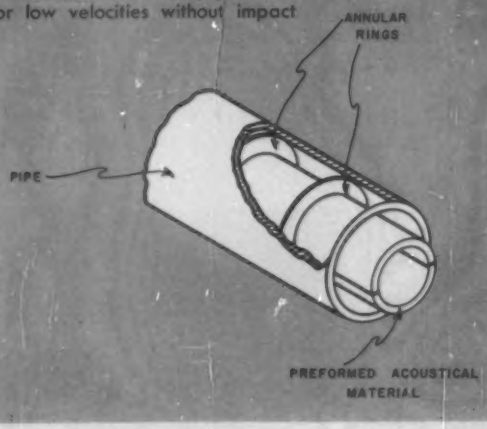


Fig. 3. Low frequencies are absorbed by dead areas between material and pipe

How to Reduce Exhaust Noise

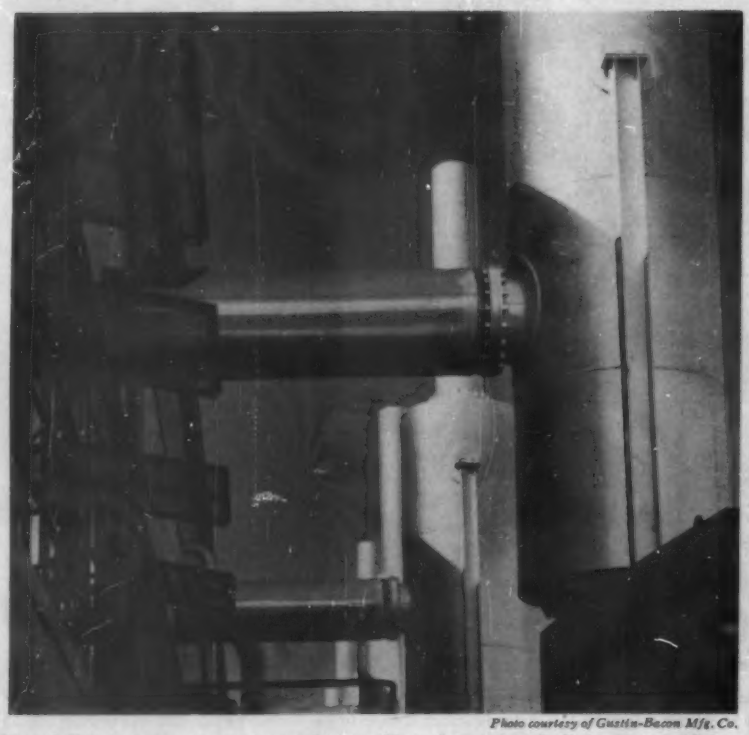


Photo courtesy of Gustin-Bacon Mfg. Co.

Fig. 4. Exhaust noise treatment makes working pleasant and eliminates complaints

This article describes use of acoustical material to absorb excess sound. Future article will discuss principles and applications of resonant chambers or snubbers

By NORMAN L. MEYERSON *

REGARDLESS of the composition of the exit gas or the manner in which it is exhausted, there is a method of reducing the noise. Noise may be generated within the system proper and be carried practically unattenuated through the associated piping to the stack by means of the flowing gas or through the walls of the piping. Noise may be produced in the stack itself or at the stack terminus where the exit gases meet the atmosphere.

If the objectionable noise is strong in higher frequency components (200 to 8000 cps) excellent results can be obtained by using internally applied absorption materials. Absorption materials may be varied to suit design requirements which may be dictated by gas velocity limitations, back pressure, temperature, and corrosion. Back pressure due to this treatment may be alleviated by an adjustment in pipe size for the "treatment run."

* Manager, Research and Development Dept., Worthington Corporation

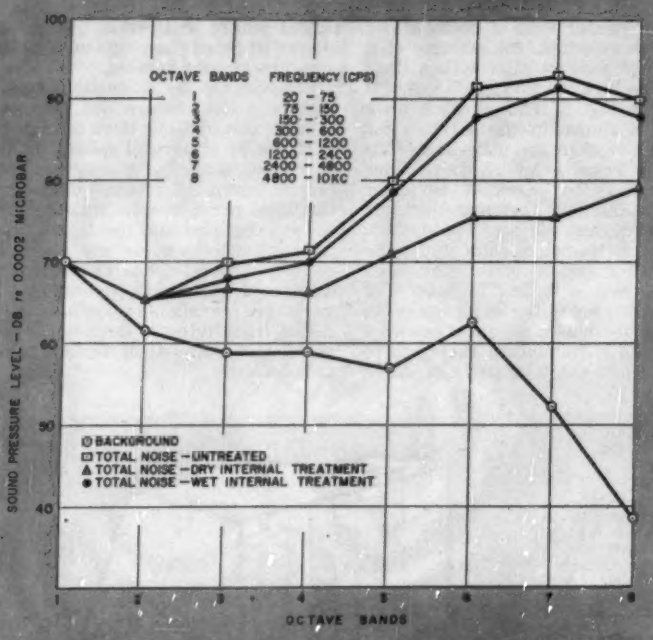

OCTAVE BANDS FREQUENCY (CPS)
1 20 - 75
2 75 - 150
3 150 - 300
4 300 - 600
5 600 - 1200
6 1200 - 2400
7 2400 - 4800
8 4800 - 10KC
BACKGROUND
TOTAL NOISE - UNTREATED
TOTAL NOISE - DRY INTERNAL TREATMENT
TOTAL NOISE - WET INTERNAL TREATMENT
SOUND PRESSURE LEVEL - DB re 0.0002 MICROBAR
OCTAVE BANDS

Fig. 5. Above. Chart showing effect of water saturation on absorption characteristics of glass fiber acoustic material

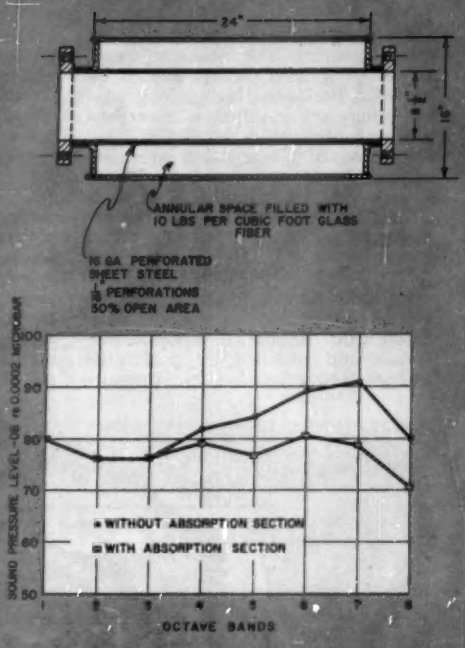

24"
ANNULAR SPACE FILLED WITH 10 LBS PER CUBIC FOOT GLASS FIBER
16 GA PERFORATED SHEET STEEL
1/8 PERFORATIONS
50% OPEN AREA
WITHOUT ABSORPTION SECTION
WITH ABSORPTION SECTION
SOUND PRESSURE LEVEL - DB re 0.0002 MICROBAR
OCTAVE BANDS

Fig. 6. Right. Shows details and response of lined exhaust pipe section in reducing high frequency sound amplitudes

Acoustical materials may be obtained that will withstand extremely high temperatures and will resist the corrosive nature of most exhaust gases and vapors.

The simplest internal treatment is that of lining the walls of the exit pipe with absorption material.

For low or moderate velocities and where direct impact is not encountered, preformed acoustical materials may be used. Preformed materials are made of fibrous matter molded into particular shapes and retained by means of suitable resin binders. They may fit into a cylindrical pipe or may be obtained as flat sheets for inserting in rectangular pipes or ducts. Contact with the outer walls is maintained in the case of the rectangular ducts by means of mortised joints (Fig. 1) or by fasteners and adhesives. Facings are not required here since there is no excessive impact of the gas stream on these surfaces. Where impact is encountered, as at a bend in the pipe or at areas where gases enter or leave the pipe, as in the case of a manifold, additional physical protection is required to prevent erosion of the acoustical material. For this purpose a facing layer of wire mesh or a layer of perforated sheet metal or composition board may be employed. For high velocity streams it is advisable to extend the perforated facing or screening to protect the entire run of acoustical material (Fig. 2).

Preformed materials are commercially available in stock sizes and may be fabricated according to individual specifications. Organic and inorganic materials are both widely used. The choice is one of economics and physical and chemical behavior under the conditions of service.

Material Selection

Among the important considerations of proper material selection is capacity of the material to acoustical waves. In most cases the density of the material has a direct bearing on its absorptivity. An optimum density exists for all materials. Proper selection of materials also must consider the temperatures to be encountered, both of the gas stream and that of the pipe or duct itself. Materials made of organic fibers can rarely be used above 200 or 300 F. Inorganic fibers other than metals should normally extend the permissible range to 1000 F. However, the binder, which in most cases breaks down at temperatures below 600 F, and thus one limiting feature of preformed acoustical materials is the operating temperature and its effect on the binder. For high temperature service the materials selected should be evaluated for flame-resistance. All acoustical materials bear one of four flame-resistance classifications: — Incombustible, Fire-Retardant, Slow-Burning, Combustible.

Federal Specification SS-A-118a defines the meaning of the above classifications.

Many exhaust gases are corrosive — the degree being dependent principally on the chemical composition of the exhaust gases. Most organic fibers are prone to acidic corrosion. Organic binders also may be attacked by the corrosive exhaust gases. This is another important limitation to the use of preformed acoustical material possessing binders. Some resins have been developed that possess unusual resistance to corrosion.

Details of the sound absorption qualities of most commercially available acoustical materials may be obtained from the Acoustical Materials Association, 59 East 55th Street, New York 22, N. Y. or from the manufacturers directly.

The decibel reduction to be expected on using internal linings is generally of the order of 1 to 2 decibels per ft of treated pipe or duct length. Attenuation at the lower end of the frequency range may be extended by providing dead regions between the acoustic lining and the pipe wall (Fig. 3). Practical limitations such as the reduction in flow and costly fabrication make this method of lower frequency attenuation somewhat unpopular.

Effective attenuation of higher frequencies can be expected when using absorption materials provided the material remains relatively dry. The efficiency of acoustic materials decreases with increased liquid or solid absorption. Fig. 5 shows the significance of dry media for absorption. The impairment is equally accentuated by oil or solid particle saturation of the sound absorbing material. Where excessive liquid carryover exists provision should be made to drain off excess fluid, and where solid

particles resulting from combustion could saturate the acoustic liner, proper perforated facings should be provided. Perforated facings for acoustic linings are obtainable from suppliers of perforated metals. A large assortment of hole and slot variations in steel, brass, and aluminum sheets is generally available. Facings with 50 per cent or greater open area are preferred for liners.

Fabricated Liners

Superior sound absorbing action can be obtained by using liners fabricated from unbonded acoustic materials and retained by perforated facings. Reductions in sound pressure level of greater than 2 decibels per ft can be expected. An example of a section of exhaust pipe with a liner for use in high velocity gas streams is shown in Fig. 6. Though glass fiber has been shown in the diagram for the sake of example, other materials perform equally well. Many liner designs may be protected by letter patents making the manufacturer of these devices subject to patent law action. Extreme caution must be exercised in order not to infringe on patents now in force. The holders of the patents are either in a position to sell the liners as a product, extend a license to manufacture them, or to sell the patent. A properly executed patent search will reveal the status of present patent coverage on internal sound treatment devices.

For even greater attenuation, sound absorbing devices are put into the exhaust stream. The devices may be in the form of parallel splitter vanes of various shapes or a series of concentric liners. All internal devices of this type provide some resistance to the exhaust flow and result in a head loss unless provisions are made to increase the pipe size to accommodate them. Figure 7 shows some of the variations available commercially. All of these internal devices contain absorption material of various types and densities.

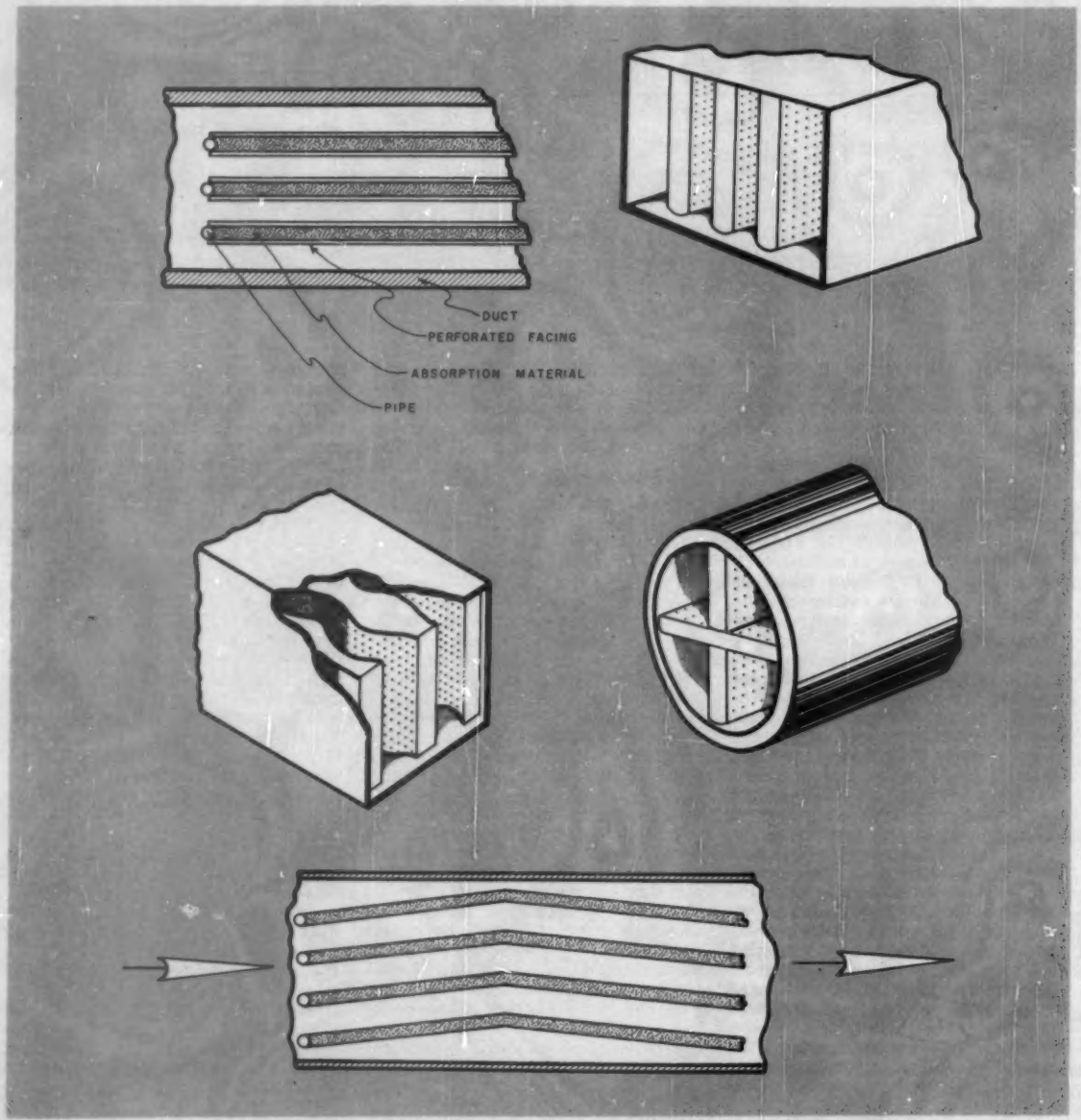
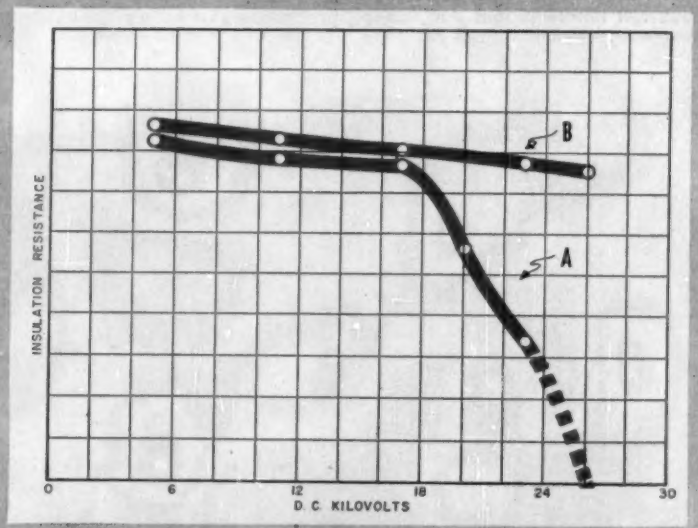


Fig. 7. Some typical ways in which sound absorbing materials are put into the exhaust stream. All internal devices of this type provide some resistance to the exhaust flow and thus result in a head loss unless pipe size is increased accordingly

So—You're Going to Overhaul Your Turbine Generator!

This is the ninth article in a series describing the scheduled overhaul of a 25,000 kw turbine generator at U. S. Steel Corp.'s South Works in Chicago. A list of past and future articles is given below. When all the articles have been published we plan to reprint the whole series. To reserve a copy of the reprint write to the Editor



IX. ELECTRICAL INSPECTION AND TESTING

Direct-current high-potential test used on this generator enabled approximate breakdown voltage to be predicted without overstressing winding insulation

Curve A shows how the approximate breakdown voltage was predicted from insulation resistance readings

I. Preview of whole series. II. Planning . . . Preparation . . . Preliminary work. III. Removing cover and spindle. IV. Turning cover. V. Reblading. VI. Metallizing eroded shaft. VII. Machining spindle. VIII. Checking clearances. IX, X, XI. Work on generator. XII. Realigning spindle. XIII. Balancing. XIV, XV. Miscellaneous. XVI, XVII. Safety and time-saving ideas

D-C HIGH-POTENTIAL TEST

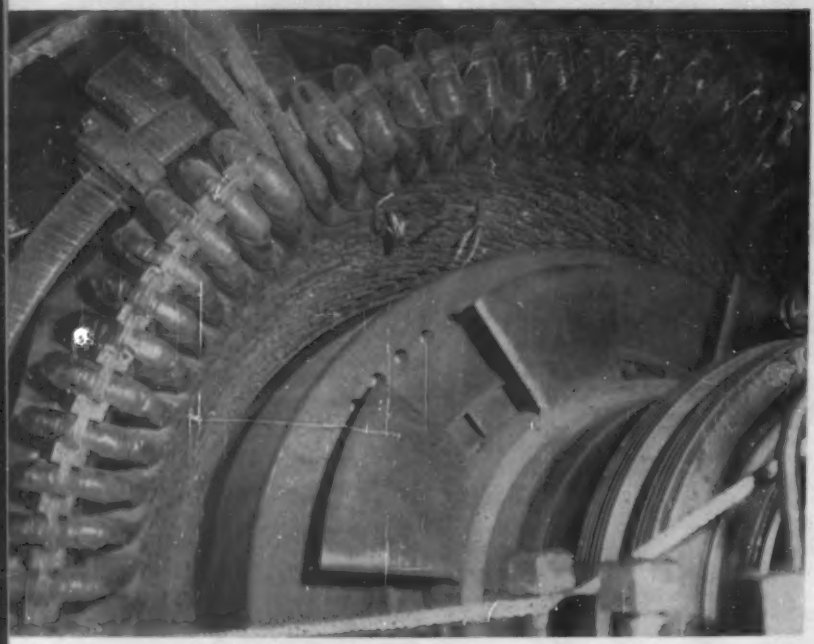


Fig. 1. Stator windings when covers were first removed looked in good shape with only a few broken cords and normal dust after several years' operation

Fig. 2. Below. Curves showing how approximate breakdown volts can be predicted from d-c high-potential test. "A" shows test before repairs. "B", after

WHILE the turbine overhaul was proceeding, preparations were made to inspect and test the generator and exciter. First the end covers of the generator were removed and a visual inspection made of the whole machine. Apart from some dust and one or two broken binding cords the stator windings, as seen in Fig. 1, appeared to be in good condition. The stator coils were thoroughly examined for any indication of insulation deterioration, dirt was removed and air passages cleaned. Coil cording was checked and slot wedges examined to make sure they were tight.

Next a d-c high-potential test was applied to the stator windings. The d-c high-potential test can be used as a nondestructive insulation test whereby the insulation breakdown can often be predicted before destructive puncture takes place.

The d-c test has the following advantages over an a-c test.

1. The d-c tester is a relatively small portable device which can utilize any convenient 115 or 230 v outlet. It is shown in Fig. 3.

2. Slightly less damage is caused if breakdown occurs with the d-c voltage than with an equivalent a-c.

3. For large generators the test equipment is easier to operate and can be set up in less time than a-c equipment.

Data from highpotential tests of several outages can often be used to give an indication of service reliability. If failure is indicated before the next regularly scheduled outage the machine can be scheduled for an earlier outage and a costly unscheduled outage can be avoided. Such a precaution also avoids the extensive

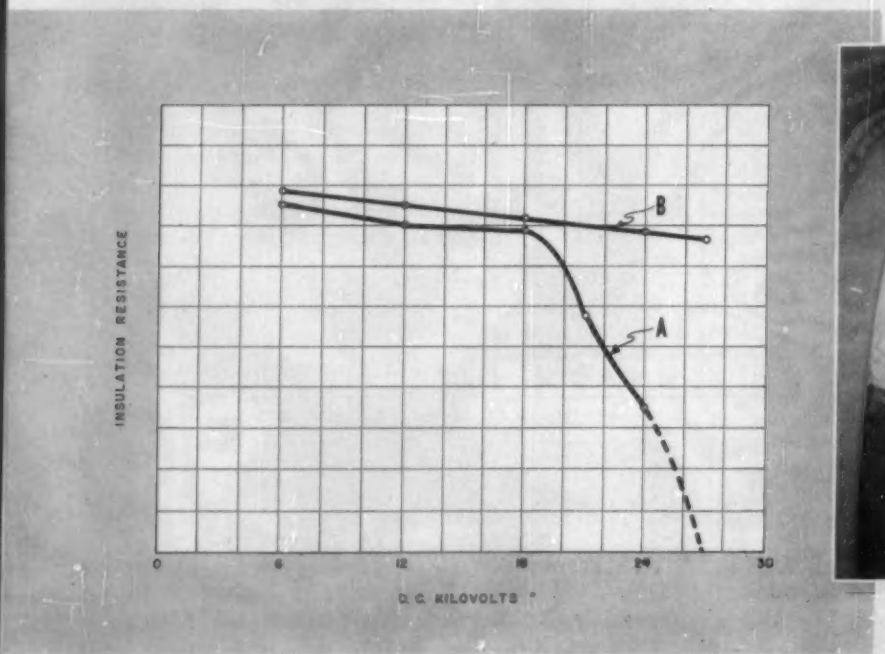


Fig. 3. Above. Taking readings during high-potential test

damage usually resulting from failure during operation.

A.I.E.E. Specifications require a voltage of twice phase to phase plus 1000 v for testing insulation on new machines.

This machine has a phase voltage of 13,800, which would require a test voltage of 28,600 when new.

In this case the d-c equivalent of the a-c voltage was taken to be approximately 45,000 v.

Because of the age of the insulation in this generator it was decided to reduce this voltage by one third and not exceed 30,000 v d-c during the test. 30,000 v is still approximately two and one half times the a-c equivalent of the normal phase to ground voltage.

As can be seen from the curves of insulation resistance against voltage in Fig. 2, it was apparent from extrapolation of the curve as the voltage was increased that a breakdown in the center phase winding was indicated at approximately 27,000 v. After due consideration it was decided to continue the test and find the weak coils. At 27,000 v the insulation was punctured on some coils in the center phase. These coils were repaired, and the test repeated, resulting in curve B, Fig. 2.

Fortunately the insulation failures occurred in the coil ends rather than in the slot portions and it was possible to repair the insulation without removing the coils from their slots. However, the parts of the coils needing attention were inaccessible with the rotor in position and in order to get at them the rotor had to be removed. This operation will be shown in the next two articles.

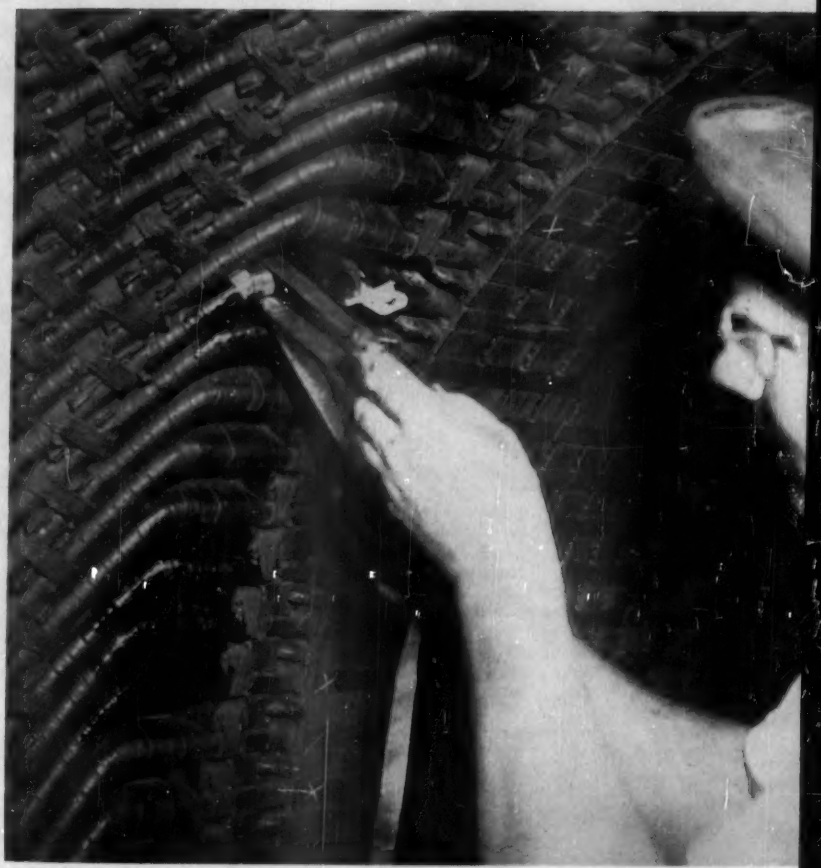


Fig. 4. After the weak coil had been repaired, several other coils were reinforced, as a precautionary measure, at the points where they emerge from their slots

To reserve one or more reprint copies of this series of turbine overhaul articles, write to the Editor

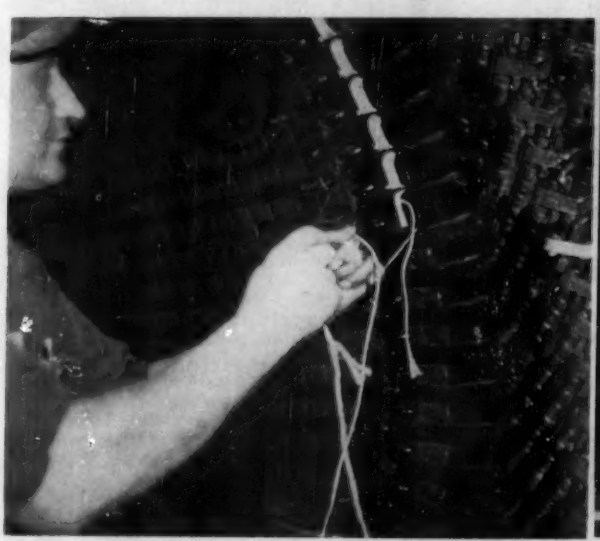


Fig. 5. Binding reinforced coils with new cord. Elsewhere in the windings frayed and broken cords were replaced

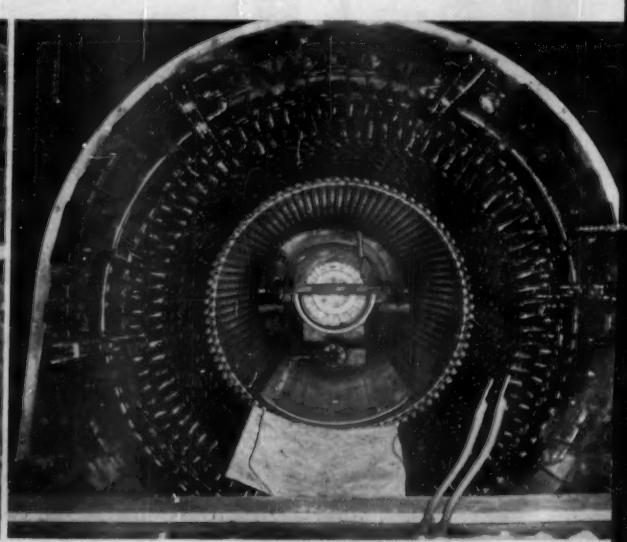


Fig. 6. Stator windings ready for rotor to be replaced. Steel pan resting on stator laminations will support the rotor

Which Will Last Longer—Your Plant

With plant equipment lasting about 35 years, it pays to look well at your coal reserves. Will they last 35 years also? How far will you have to haul coal 20 or 30 years hence? Will the ash fusion temperature be the same? Dayton P & L looks ahead for the answers

By FRED M. REITER *

UTILITY COAL buyers must examine the reserves and production capabilities of the sources of coal from whom they obtain their "steady" supply of coal. Utilities purchase rather large tonnages of coal at comparatively uniform monthly rates. Power consumption today by the public does not vary so much from month to month or season to season because electric sales have smoothed out the larger irregularities of load by off-setting heavier winter lighting consumption with summer air-conditioning. Industrial power loads have a stabilizing influence on the coal consumption during the year.

Where fuels are used for winter heating, the curve of monthly consumption does follow a sine curve of successive winter hills and summer valleys. The average coal producer finds that his overall demand follows the up and down cycles, particularly in the various domestic sizes of coal. He usually finds that some sizes will be a glut at times while other sizes move rapidly and that the situation is in constant change among these different sizes. In recent years there has been a drift toward producing a nut-slack (2 or 1¼ × 0) size by crushing all of the coal produced to this single product. It is a move away from domestic production, toward industrial and utility markets. Balancing the movement of domestic sizes of coal is truly an art.

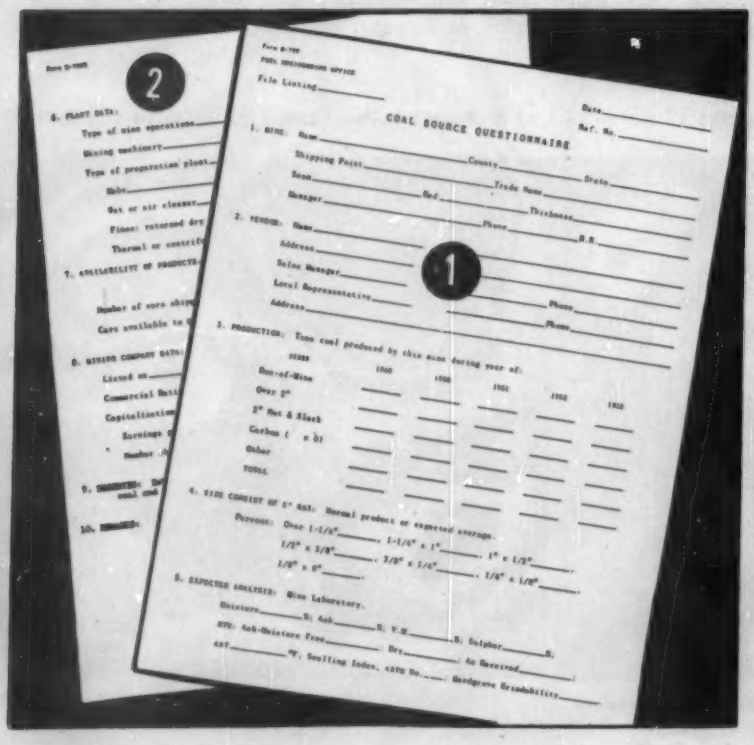
From the viewpoint of a utility coal buyer that can use the carbon size to advantage, knowledge of the product sizes made by any given mine becomes important. For purposes of evaluation, we designed our coal source questionnaire to list the production of the sizes pertinent to our procurement, for the previous five years. It makes no difference to us whether a mine produces 6-in. or 7-in. lump, 6 × 4 or 5 × 3 egg, 3 × 2 intermediates, or 2 × ⅜ or 1¼ × ¼ stoker sizes for domestic sales, so these sizes are omitted from our questionnaire. The run-of-mine tonnage indicates the gross production that can be converted into the other sizes.

Any coal sizes between the run-of-mine (ROM) and the "over 2-in", comprise the range of domestic sizes. Our interest would lie in the nut-and-slack, 2 × 0, and the carbon sizes.

If the 2-in. nut-slack is equivalent to the run-of-mine tonnage, we could assume that all of the output of the mine is crushed for industrial or utility use, with little domestic or carbon sizes available. Some carbon size may be produced if modified nut-slack coal of a specified size consist containing a limited percentage of fines is assembled for shipment. Otherwise carbon production generally ties into the domestic tonnage, double screened stoker sizes in particular.

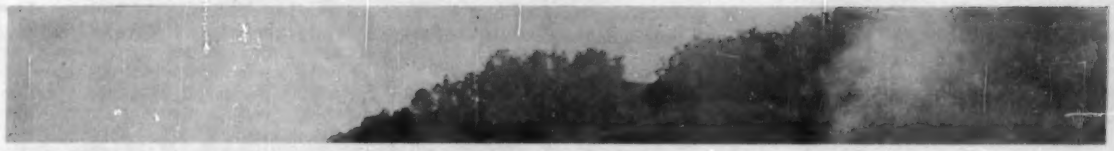
The above discussion is merely to point out the reasoning behind the size groups selected for our evaluating the production capacities of mines. Figure 1 illustrates the front side of a double-sided questionnaire form. Paragraph 3 sets up vertical columns with the sizes discussed above. Across the page are tons of each size of coal produced by the mine each year for the previous five years, portraying the trend in output as a possible projection for the next few years. The cause of the rise or fall in production might be traced to competitive costs, changes in quality in better preparation or the emergence of faults or changes in methods of mining. The questionnaire thus forms the start of an historical file to which can be added records of analyses, etc.

On the back side of the questionnaire, Fig. 2, the plant equipment is listed. Any changes, such as the addition of washers, thermal dryers, and so on, will help account for changes in quality and production. Paragraph



Figs. 1 & 2. Check lists such as Dayton P & L's help coordinate characteristics of coal reserves for specific stations

* Fuel Engineer, The Dayton Power and Light Company, Dayton, Ohio.



or Your Usable Coal Reserves?

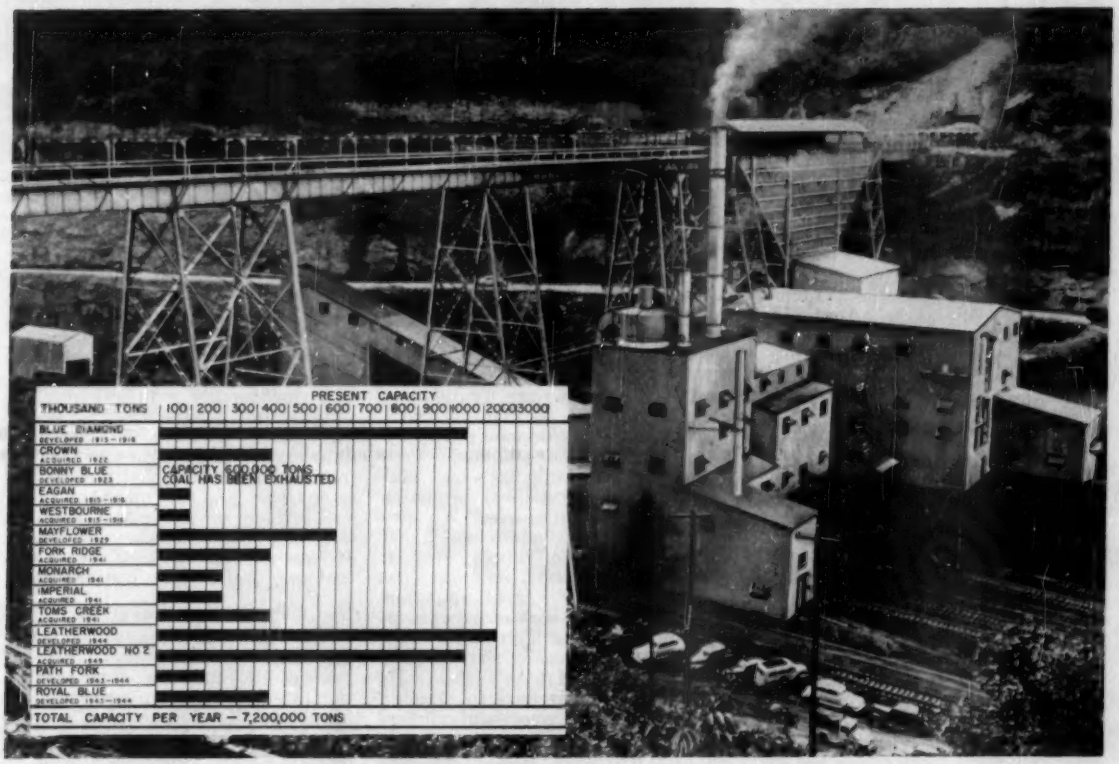


Fig. 3. (inset). Capacities and state of development of specific mines in area help forecast reserves available to plant

Fig. 4. Mines' facilities (screens, washers, etc.) are helpful in forecasting their products' physical characteristics

7 provides the final information as to the availability of the coal to our company, and the total number of cars shipped, so that capacity need not be judged by offers to ourselves. The percentage allotted to any one company may be quite small relative to the gross output of the mine.

This questionnaire, in paragraph 9, asks how many years lie ahead of the mine for this production capacity. This information has been directly requested in some cases, and offered to us separately by others. Accurate information for fair estimates may not be readily available as part of a form questionnaire handed to all coal representatives. Where long term purchases are planned, or contracts contemplated, longevity assumes importance and more detailed information is desirable. Spot purchases are not accompanied by the need for complete historical background that includes reserves for single mines.

Reserves are generally useful when based upon broad studies by competent engineers and geologists. Most such studies cover complete seams or types of coal in specifically designated areas, as will be found in the publications of State and Federal geological or mining statistics.

The fact that mining operations start with land leases, complete sets of borings are probably made to measure the coal depths, seam thicknesses, faults, etc., in order to establish mining values and procedures. It can be implied that recoverable tonnages are determined for the area under consideration, for as many seams and types of coal as may be found within the area. These reserves are known to the individual mine engineers or owners. Some of these separate operations may form part of the statistics found in buyers' guides, or circulars or material that can be supplied by the mine representatives.

Power stations, steel mills, chemical plants and other large users of coal are interested in their own particular types of coal; i.e., for steam boilers, coke plants, chemical processes, and so on. The steam plant may be designed for its specific type of coal: very low fusion coal for cyclone type furnaces; high fusion coals for underfeed stokers; medium fusion for spreaders; carbon size coal for pulverizers. The metallurgical plant may desire high quality low sulphur and ash coal of low volatile high swelling index characteristics, or high volatile high rank coking coals, so that the two may be mixed to give the proper shrinkage and form load bearing blast furnace coke.

Both of these categories of consumers will demand large monthly

Table I. Summary of data on resources, production capacities and costs of various types of coal proposed for use at a power station, classified in terms of three ash liquid point ranges; applied to areas within economic cost range

	Range of liquid points, deg. F		
	Under 2400 F	2400 to 2700 F	Over 2700 F
Estimated minimal recoverable reserves, million net tons	1,700	1,700	1,300
Estimated annual production, million net tons	48	51	36
Estimated minimal years of supply at current rate of production	35+	33+	34+
Average price of size used, per net ton f.o.b. cars	$ 3.50	$ 3.30	$ 3.90
Freight including 4¢ tax per net ton	$ 3.30	$ 3.66	$ 3.66
Destination price expected per net ton	$ 6.80	$ 6.96	$ 7.56
Expected average BTU per lb. as received	12,500	13,500	13,700
Expected costs, cents per million BTU as received	27.1	25.8	27.6

tonnages of coal. Reserve capabilities are needed by both on the availability of their coals in the future, over large areas, far beyond the leases of individual mines. Each point of consumption has its natural source areas where the economics of transportation costs, zoning and routing, and handling facilities are most favorable. For Dayton, Ohio, coals within the inner-crescent rail freight zone would get preference. These coals would come from Ohio, West Virginia and Eastern Kentucky.

As an example of the treatment of the problem of reserves, we made a study in preparation for a decision as to the type of firing equipment that should be utilized in any new boilers that might be installed at one of our stations. This station was located in an area not unfavorable to coals of all ranges of ash fusion temperatures available at comparatively equivalent destination costs.

Know Fusion Points

The lowest fusion and freight rate coals would favor cyclone furnaces, although not at the lowest destination cost per million Btu, because of the lower heat content of these coals. Our ability to utilize lower priced high heat value coals of higher ash fusion temperatures might favor high heat release pulverized firing equipment. An estimate of the minimal available recoverable resources of coals within our natural area was made, in terms of three groups of coals classified with regard to their ash liquid fusion points. The ranges selected for these three categories were: (1) under 2400 F, (2) 2400 F to 2700 F, and (3) over 2700 F.

Table I summarizes group totals for the three ranges that we derived from available sources. The minimal recoverable reserves that we have listed may be considerably lower than the total figures found in all published records. Known workable reserves of all fuels have the habit of increasing yearly in spite of the annual removal or depletion. Gas and oil reserves seem to increase each year because of new discoveries in new areas, or from new borings or revised estimates.

Table II makes a similar summary for coals that we can use, for different geographical areas of origin for those coals that are in economic proximity to our stations. The tabulated figures derived by us on this basis may also vary with the statistical estimates made by various sources. We frequently hear of life values like "1,000 years of available supply" which makes our figures seem very low. Coal is undoubtedly our most abundant fuel. Yet, on the other hand, we get reports of scarcity of high fusion type, high Btu steam coals. Actually the areas or origin of high fusion coals for our use has seemed to broaden without diminution of supply. Perhaps other seams of comparable coals adjacent to the originally mined seam are brought to the same tipple or shipping point; or new entries become more economical in production, utilizing truck hauling to the tipple.

Reduction in quality occasioned by these alterations in mining, or where partings or faults are encountered, is compensated for by better methods of preparation and drying. Production of good steam coals available to us seems to continue, even increase, as our own demands grow. We expect it to continue so for many years.

Power generating boilers become obsolete with increasing rapidity. New developments in engineering, in pressures, temperatures, capacities, designs and economies, seem to come faster. Power demands are increasing at a rate that seems to double the requirements every 10 years. Experience points to the replacement of equipment in 35 years, so that a new evaluation of the entire coal and equipment situation must be undertaken. The same data must be reaccumulated as to the reserves, characteristics, costs and transportation aspects of the coal supply. Right now a new look at atomic energy or other fundamentally different energy sources may render estimates of reserves available beyond 35 years to specific points of consumption for power generation or for some other uses, subject to further scrutiny.

An examination of the tables would indicate that all of the coal fields that are natural supply sources to us, could serve the boilers under consideration throughout their normal life expectancy. Economics, in terms of costs, transportation, and so on, along with the suitability of the coals in terms of combustion properties, then become the more important factors, since all types of coal fulfill the supply needs.

The situation among the individual suppliers within a given coal origin area is very important in considering the selection of long term suppliers. A coal questionnaire submitted by a supplier on a specific mine, should contain an estimate of the minable reserves of the precise seam of coal quoted on and accepted for shipment.

Many areas have a number of seams located within reach, in layers at various elevations. The properties of the coal in the different seams may vary considerably and may not all be suitable for the equipment for which the coal is purchased. We have had some cases where mixtures of the coal from several seams that supply the same tipple, and coal other than that specified on the order was accidentally shipped. Hence any statement of reserves must be confined to the coal specifically under consideration.

Projecting Reserves

The reserves of a mine are normally expressed in terms of tons of coal and years of life. Since the 5-year production rate is given in our questionnaire form, the life can be readily computed (see par. 9 of the questionnaire, Fig. 2). This data should be available without much effort on the part of the coal representative because the mine supervisors or engineers maintain progress data and area prints of their operations.

Reserves seem to bear a common ratio to annual production for most types of bituminous coal. Exploration becomes favored by high demand and increased revenue, as though the human factors of sales effort, financial and engineering curiosity, encourage development. This seems to be equally true of other fuels, such as gas and oil.

The years of supply given in the tabulations, averaging around 35 + years of minable reserves, may seem low to the average reader, based upon figures that have come to his attention. We can, for the benefit of these readers, mention estimates that have been made on undeveloped reserves, which would be in addition to the more known recoverable reserves listed in Tables I and II. Railroad coal personnel have made pretty good studies of coal lying in their areas of origin. They normally pro-

Table II. Summary of data on resources, production capacities and costs of suitable coals proposed for our use, classified in terms of six areas of coal's origin

	Area of Origin of Coal					
	Ohio Area	Northern West Va. area	Southern West Va. area	Eastern Kentucky area	West Kentucky area	River Barge area
Estimated minimal recoverable reserves, million net tons	520	650	1,500	1,700	600	75
Estimated annual production, million net tons	11	19	35	50	18	3
Estimated tonnage available to our company per month	50,000	30,000	20,000	30,000	30,000	30,000
Estimated minimal years of supply at current rate of production	50+	35+	43+	30+	33+	25+
Expected average Btu per lb as received	12,300	13,000	13,600	13,300	12,000	13,700
Expected average costs, cents per million Btu as received	26.8	27.3	27.75	26.15	28.4	26.3
Ash liquid point, deg. F	−2400	2400/2400	2800	2400/2700	2400	2700

The above tonnage figures are taken from a number of sources and are minimal or currently assured

ject possible extensions of their lines into their territories where sufficient tonnage may assure returns. They are very cooperative to consumers as well as producers of coal.

To Table I we might add to the minimal recoverable reserves, under titles of "estimated undeveloped reserves" such as are quoted in the following tabulation for our area:

Estimating rail group	Range of Ash Liquid Point, deg. F		
	Under 2400	2400 to 2700	Over 2700
	In Millions of tons		
A	2,650	500	500
B	—	3,565	—
C	600	2,300	1,760
Total	3,250	6,365	2,260

A fourth rail group would make no concrete tonnage estimates, but assured us that reserves were of such size as to cause no concern during the useful life of any equipment that might be installed in the near future. Each rail group covered their individual areas, so that all estimates must be totaled for the territory under consideration.

In checking Table II for the total reserves estimated by geographical areas, data from the Department of Interior shows some very extensive reserves of coal. For the selected states that could economically serve our area of southern Ohio, we find these figures (1):

Bituminous coal available as of January 1, 1950
Total for the United States
Assured recoverable reserves
184,900 million tons
Ultimately recoverable reserves
616,320 million tons

Recoverable reserves of individual states that can economically supply our area, assuming 50% recovery:

Ohio	41,550	million tons
Kentucky	59,710	" "
Pennsylvania	30,130	" "
Tennessee	12,510	" "
Virginia	10,035	" "
West Virginia	53,330	" "

The life expectancy of bituminous coal might be derived from their data, but errors common to all similar predictions on long term reserves can affect these estimates:

Total United States Bituminous Coal (Estimates as of January 1, 1950)

Assured recoverable reserves 184,900 million tons

Production Rate		Years of Life After Year Indicated
Year	Million Tons	
1940–50	544	340
1960	650*	275
1980	750*	230
Ultimately recov. reserves 616,320 million tons		
1940–50	544	1130
1960	650*	920
1980	750*	770

* Author's evaluation of recent predictions.

Conclusions drawn by the authors of the circular indicate that only 15 per cent of the gross coal reserves comprise *measured* coal reserves in seams or beds 28" or more thick under less than 2000 ft overburden. Another 15 per cent is *indicated* as coming within these same seam and depth workable limits. Tables 1 and 2 assumed 50 per cent recovery. These factors portray the fact that reserve capabilities must be properly estimated. Total acreage, thin unworkable seams, small inaccessible areas and similar handicaps need to be carefully evaluated. Individual mine figures are generally dependable, especially on short ranges of decades, because of the fact that engineers make the studies for actual production planning, using fairly precise technical methods. Estimates on our questionnaire forms for separate mines should be fairly reliable. They can serve as guides in evaluating sources of supply. In fact it is the purpose of this article only to serve as a guide to those responsible for planning a coal procurement program, not to present factual data on precise tonnages or years of life.

Table III. One source estimate of distribution of coal throughout the world, showing plentiful supply of native coal

Country	Millions of Tons	Per cent of World total
United States, including Alaska	2,117,931	36.72
U. S. S. R., both Asia and Europe	1,322,723	22.9
China	1,115,098	19.3
Germany	370,679	6.4
United Kingdom	189,818	3.3
Union of South Africa	226,409	3.93
Canada	98,816	1.72
Poland	88,205	1.5
India	71,624	1.3
Australia	58,533	1.02
Czechoslovakia	20,889	0.37
Japan	18,399	0.32
France	7,055	0.13
Balance of world	61,249	1.09
World Total	5,767,429	100.00

Taken from Bituminous Coal Annual of the Bituminous Coal Institute, Issue for 1953, page 41.

Table III is added for general information on the world reserves of coal. This is the third set of estimates offered in this article, its figures exceeding the data previously given. Some of the estimates, such as U. S. S. R., may not be up to the minute. It does present the relative picture of the distribution of total coal throughout the world. The only value of this tabulation to an American coal buyer would be to better his understanding of the export situation in coal. The U. S. is in an excellent position with regard to its own assurance of native supply. Extensive export may have some bearing on his "logistics."

To add to the confusion of thought on coal reserves that may be available 50 or more years from today, attention has been called frequently to the tremendous acceleration of the energy consumed by the human race. We are advancing energy consumption in a geometric progression. For the past 35 years U. S. power production has doubled every 10 years. Right now the doubling rate is even faster. Our export of coal to foreign nations is now very high. If the burden of all this energy expansion falls upon U. S. coal reserves, a glance at Table III might indicate that this continued drain may use up much of our coal reserves by the year 2000, 45 years hence. I have already heard this prediction publicly announced. The atomic age is truly advancing fast. Our succeeding crops of coal buyers may either have quite a job or no job at all.

(1) Geological Survey Circular 94, Dec. 1950, by Averitt and Berryhill, page 4.

Editor's Note: While the development of the atomics industry may slow the sale of fuel coals, chemical use will doubtless cause a net gain.

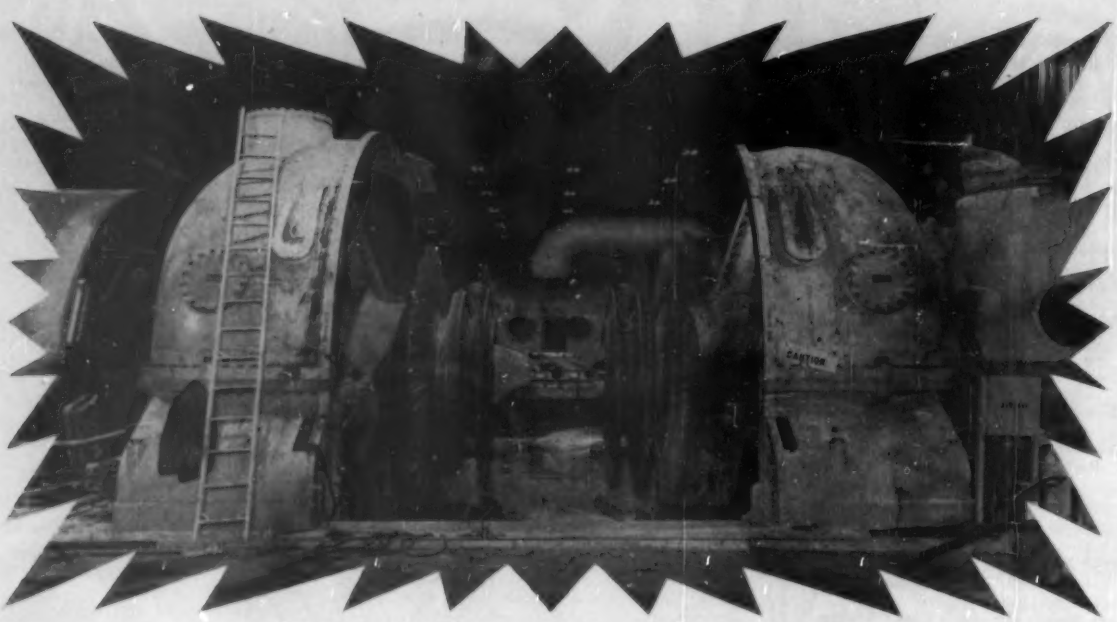


Fig. 1. Close-up of Ridgeland No. 4 low pressure turbine after the accident

Report on Ridgeland Turbine Failure

On Dec. 19, 1954, the 1-p spindle of Ridgeland No. 4, a 165,000 kw unit, burst during a routine overspeed test, killing two men and injuring five others. Here is a summary of the investigation report

THE MACHINE: Ridgeland No. 4 was a conventional cross-compound set; high-pressure turbine running at 3600 rpm, intermediate and low-pressure turbines in tandem at 1800 rpm. Figure 3 shows the l-p spindle arrangement.

Operating history before failure: The unit was first brought up to speed on July 17, 1954. Five overspeed runs were made on that date and the unit was placed in regular scheduled service on Aug. 19. There were a total of ten start-ups, including nine overspeed tests prior to the disaster on Dec. 19. Vibration history of the turbine was excellent; its operation was smoother than average in the opinion of both manufacturer's field engineers and the station operators.

Events of Dec. 19th: Unit No. 4 was taken off the line Dec. 17 for boiler cleaning. Both shafts were kept on turning gear until the evening of Dec. 19th. Then speed was brought up to 3000 rpm, as measured on the h-p shaft, in about an hour and a half, and the vacuum trip setting was checked. Then the h-p shaft governor was made inoperative and speed was increased until the l-p governor tripped the unit at 7.8 per cent overspeed. Then the l-p overspeed trip was made inoperative in order to test the h-p overspeed trip. Speed was then increased and at 3910 rpm, or 1955 rpm on the l-p shaft, corresponding to 8.6 per cent overspeed, the l-p spindle exploded. The accident occurred without warning, there being no noise or rubs or other abnormal indications up to the instant of failure.

The main body of the spindle burst into four main pieces. One piece was hurled through the air and fell into a basement adjacent to the condenser of unit No. 1. Another piece flew in the opposite direction and landed in the station coal pile. The remaining two pieces came to rest in the condenser of unit No. 4. Various other fragments were thrown around the station, causing damage that shut down the whole plant.

Analysis of failure: Probable sequence of failure is believed to be as shown in Fig. 2. The failure was explosive in nature and occurred completely in a very small fraction of a second, but the sequence is believed to be as follows:

1. Initial failure started at the bore within the main body and progressed in a longitudinal plane both radially and toward the shaft ends, tending to split the main body into two halves.

2. Extension of the primary failure into the shaft ends was limited by the clamping effect of the shrunk-on rings. These rings also restrained the two halves of the main body, and extremely high stresses were set up at the fillet corners between the shaft and main body of the spindle. Secondary failures from these corners immediately progressed in an inward direction toward the center of the main body.

3. As cracks from the fillet corners progressed in a direction to free the halves of the main body, strong centrifugal forces in each of these halves almost simultaneously split them into quarters. At the same time the center portion of the material enclosing the bore in the main body fragmented, leaving conical segments attached to each of the spindle extensions. These segments, already split in two by the original primary failure, also quartered with the larger pieces.

4. The quarter-sections of each of the cones, eccentric and overhung and possibly not yet completely free of the main central pieces, tended to break off at the points of restraint under the rings. At some locations

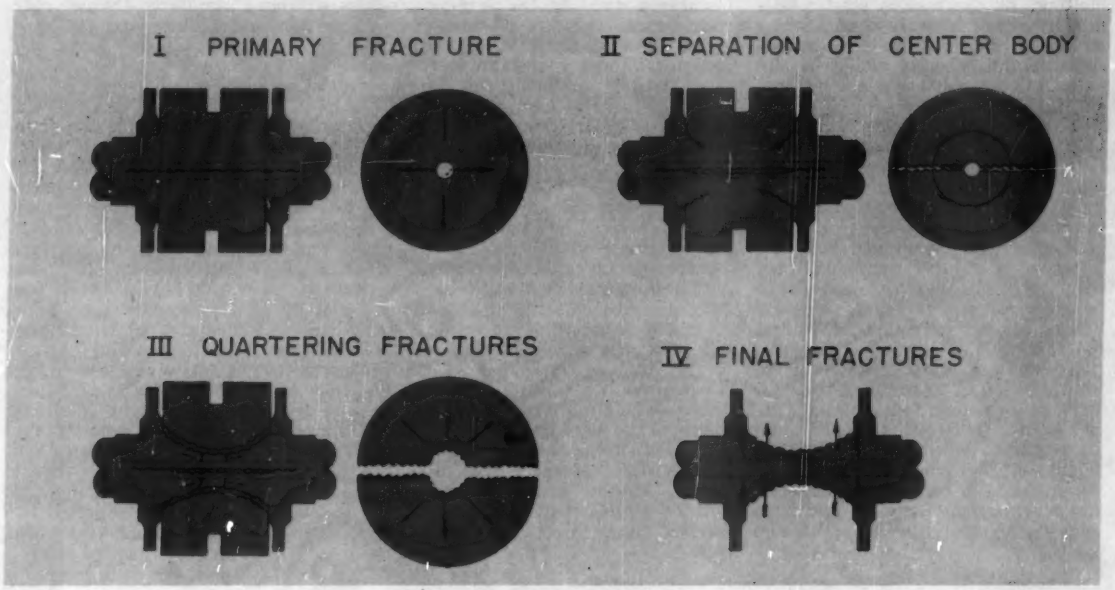


Fig. 2. Diagram showing sequence of failure. Explanation is given in the text

these segments broke free, at others, portions remained attached to the shaft extensions.

Cause of Failure: A study of the sequence of failure indicated that it originated deep in the mass of the main body of the shaft. Metallurgical examinations have confirmed that the metal was notch sensitive and susceptible to brittle failure. Various inspection techniques have shown the presence of an over-abundance of cracks in the form of flakes, providing the notches necessary to trigger a sudden and catastrophic failure of the shaft.

Brittle failure is associated with the inability of certain materials, particularly in large masses, to plastically deform in the presence of a stress at the root of a sharp notch. In such materials a moderate or low stress may be sufficient to initiate failure in the presence of notches or similar stress raisers. Brittle failures are characterized by sudden cleavages at extremely high rates of propagation, perhaps 600 fps or more.

Nearly all currently-available high-strength materials for turbine spindles and generator rotors are susceptible in varying degrees to brittle failure, and great care is necessary to ensure that notches which could lead to brittle failure are not present.

In the Ridgeland spindle the notches triggering the failure were hydrogen flakes. Conditions leading to the formation of flakes in large turbine spindle forgings are fairly well established. Atomic hydrogen is highly soluble in molten steel and becomes available to a varying degree from the moisture present during

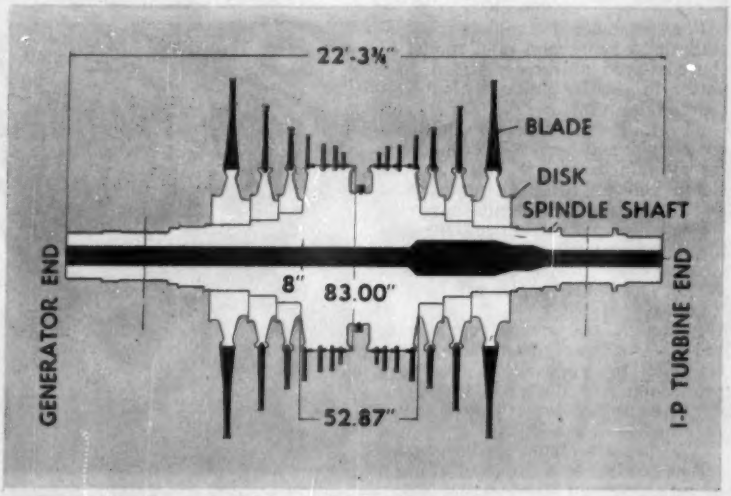


Fig. 3. Construction of double-flow spindle. H-p blades set in grooves machined in spindle. Last three rows in each flow set in heavy rings shrunk on spindle

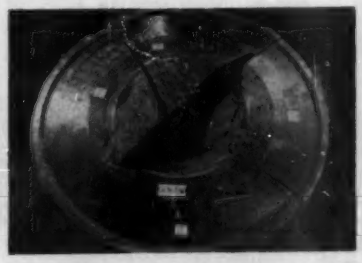


Fig. 4. Generator-end view of the assembly of the four quarters of the burst spindle body after the explosion

Fig. 5. Sulfur print of longitudinal slab from one of the quadrants showing sulfur segregates or sulfide stringers

melting. As the molten steel solidifies, hydrogen is evolved and forms molecular hydrogen gas in the microcavities and internal voids in the metal. As gas collects in these pockets, the resultant pressures may rise to extremely high values.

During the transformation of steel in cooling from high temperatures, high thermal stresses are set up in large ingots due to relative volume changes between core and rim. These cooling stresses, combined with the effect of entrapped hydrogen, may result in metallic separations or cracks variously identified as thermal cracks, segregation cracks, or hydrogen flakes.

These flakes vary considerably in size, and it is sometimes difficult, during ultrasonic examination, to distinguish between an individual flake and a harmless non-metallic inclusion. Furthermore, flake orientation tends to be in radial planes in large cylindrical forgings, and thus edge-on to sound waves projected inwards normal to the forging circumference.

On the other hand, it is generally recognized today that flakes have the characteristic of being present in large numbers if they appear at all, and of being fairly well distributed circumferentially in a band at about mid-radius in the forging.

While the sequence of failure shown in Fig. 2 was originally deduced from examination of the fragmentation of the Ridgeland shaft, it has since been confirmed with considerable accuracy by bursting tests with $\frac{1}{16}$th size cast-iron models.

The only point of uncertainty is the means by which the shaft maintained its integrity as long as it did. It is probably that failure started when one or more of the numerous flakes in the main body near the bore extended slowly and approached the bore surface, a region of high local stress. At this instant, the brittle nature of the material caused this surface crack to widen into a major separation at an extremely high rate.

Whereas the ultrasonic-test characteristics of flakes are fairly well established today, they were not understood to the same degree in 1951, when the Ridgeland forging was tested. This accounts for the judgment at that time, based on visual inspection of the bore, that the Ridgeland forging contained harmless inclusions rather than the more dangerous flakes.

Full details of the investigation and analysis, including the model tests, are given in ASME Paper No. 55-A-172, by H. D. Emmert, Asst. Chief Engineer, Steam Turbine Department of Allis-Chalmers Mfg. Company, which was presented at the 1955 Annual Meeting.

Further details of the investigation, and precautions taken to avoid similar failures in future were discussed during the ASME Diamond Jubilee Annual Meeting in Chicago last month, and will be reported in a future issue of POWER ENGINEERING.

BCR Plans Second Automatic Steam Generator

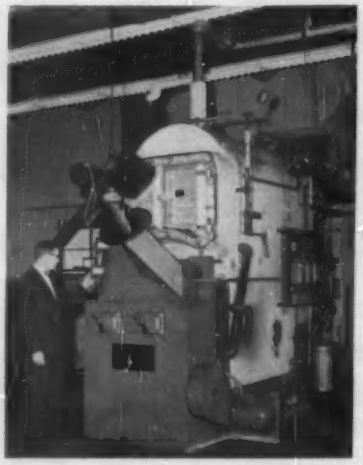
PLANS are being completed for installation of a second pilot model of the coal-fired automatic steam generator in the Bituminous Coal Research laboratory.

The unit will include a BCR-designed water-tube fire-box boiler to be manufactured by the International Boiler Works Company and a Riley air-cooled oscillating-grate stoker. This very compact, streamlined package will have a head room clearance of 7 ft 3 in. and a width of 49 in. The boiler length will be 7 ft 9 inches.

Although the main components have never been used before, the combination appears to be very promising. The design is the result of the combined experience of Riley, International, and BCR.

The present model of the generator consisting of a BCR-adaptation of an American Engineering Company Vibra-Grate stoker and a Kewanee fire-box boiler has been performing well. Changes in the design of this generator will permit the use of higher caking coals.

One of the outstanding features of the automatic steam generator is the BCR-designed system of controls. The controls are a simple combination of mechanical and electrical switching equipment consisting of synchronous timers, cams, and micro-switches. This equipment is adaptable to the widest size range of vibrating and oscillating-grate stokers for completely automatic operation. Its simplicity gives it strong advantage over the controls used with other fuels — no delicate or highly sensitive electronic components are included.



Paul O. Kock of BCR checks controls of test model of automatic steam generator

The major components of the control panel are (1) the hold fire control, (2) automatic starter, and (3) stoker timer. BCR has applied for a patent on the timer.

Objectives of the BCR research program include the development of (1) a compact, efficient boiler fired by a stoking device which will burn coal smokelessly and permit continuous mechanical ash removal; (2) a stoker-boiler unit which will operate automatically through a wide load swing, reduce or eliminate manual rekindling of the fire, and provide for automatic start from a banked or idle condition; (3) automatic ash-removal equipment, controls, and other auxiliaries which can be combined with the stoker-boiler unit to form a complete package and can be factory assembled and tested; (4) a control system reliable and simple enough to permit operating personnel to make any repairs or adjustments, and (5) a coal-fired package unit with an initial cost comparable to that of competitive equipment.

It is anticipated that this automatic coal-fired unit will have a size range from 1,500 to 20,000 lb of steam per hr and pressures up to 300 psi. It will be applicable for space heating, process hot water, and high-pressure process steam installations.

Westinghouse to Build Reactor for Duquesne

DUQUESNE LIGHT CO. has awarded the Westinghouse Electric Corp. a $2,500,000 contract to build the turbine-generator for the nation's first commercial atomic-powered electric generating station at Shippingport, Pa.

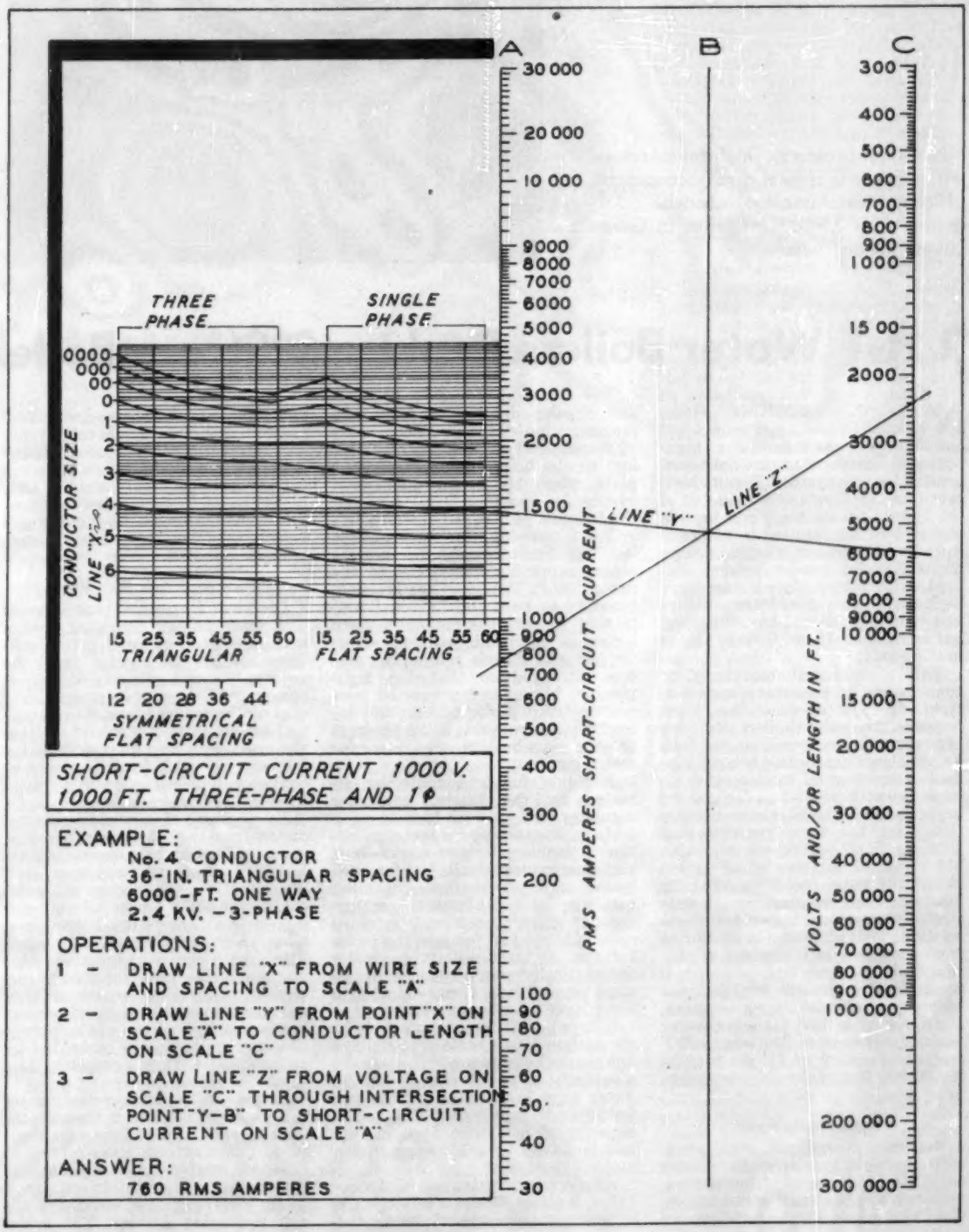
The Shippingport project is scheduled for completion in 1957. The Westinghouse Electric Corp., under AEC contract and supervision, is building the nuclear reactor for the plant. Duquesne Light will build the electric generating portion of the new plant and will operate the entire station.

The turbine-generator contract announcement calls for a unit with a capability of 100,000 kw. Installation of the turbine-generator is scheduled to be completed by July 1, 1957.

SHORT-CIRCUIT CURRENT CHART

Submitted by R. R. Taggs

This chart was developed by General Electric's great Charles Proteus Steinmetz as a quick method of finding short-circuit currents in distribution circuits. Example (lower left-hand corner) shows how to use it



SHORT-CIRCUIT CURRENT 1000 V. 1000 FT. THREE-PHASE AND 1 ϕ

EXAMPLE:

No. 4 CONDUCTOR
36-IN. TRIANGULAR SPACING
6000-FT. ONE WAY
2.4 KV. – 3-PHASE

OPERATIONS:

1 – DRAW LINE "X" FROM WIRE SIZE AND SPACING TO SCALE "A"

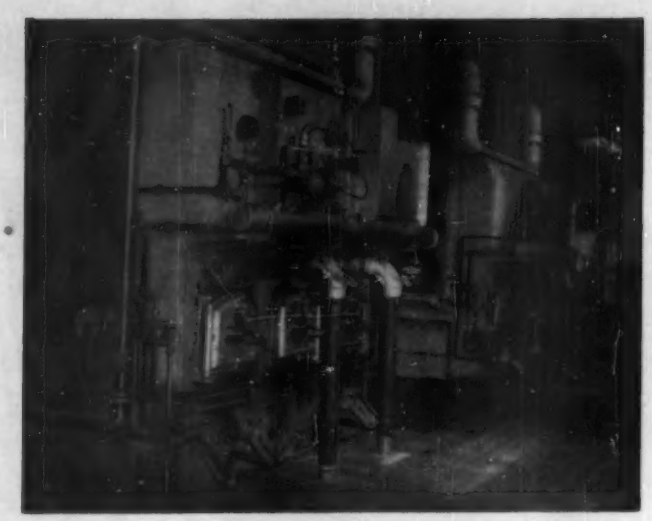
2 – DRAW LINE "Y" FROM POINT "X" ON SCALE "A" TO CONDUCTOR LENGTH ON SCALE "C"

3 – DRAW LINE "Z" FROM VOLTAGE ON SCALE "C" THROUGH INTERSECTION POINT "Y–B" TO SHORT-CIRCUIT CURRENT ON SCALE "A"

ANSWER:

760 RMS AMPERES

Fig. 1. View of two new high-pressure, high-temperature water boilers installed in new plant serving new hot water system, Naval Supply Depot



New high-pressure, high-temperature water heating system gives economical, efficient space heating, absorbs additional 10,000,000-cu-ft load, at Great Lakes, Illinois, where - - - - - - - - -

2 H-T Water Boilers Replace 9 Steam Boilers

NAVAL SUPPLY DEPOT, Great Lakes, Illinois, has completed one season's operation of a high-pressure, high-temperature hot water type of heating system. Results indicate that the progressive planning of the United States Navy is adopting this system has resulted in economical and efficient space heating. Two 20,700,000 Btu-per-hr boilers, coal fired, with oil auxiliary firing, have replaced nine individual steam boilers in a central plant and have absorbed an additional 10,000,000 cu ft of heating load.

This new central heating plant consists of two pneumatic-spreader-stoker-fired, forced-circulation, high-temperature water boilers and one expansion drum, common to both boilers. Auxiliary furnace firing equipment comprises oil burners and accessories with provisions for gas firing included in the oil burner installation. Each hot water generator has 2350 sq ft of heating surface, with 814 cu ft of furnace, which is enclosed with water-cooled walls, totally insulated and encased in 16-gage steel. Conventional boiler drums are omitted; instead, water is circulated from each unit to a common expansion tank where makeup is added, if required. The boilers are designed with forced-circulation water tubes, multipass cross flow, for a hot water working pressure of 300 psig, 420 F and an efficiency of 81 per cent at 20,700,000 Btu per hr and continuous firing.

Firing Equipment

Boilers are equipped with pneumatic coal-bin type spreader stokers employing a 3-speed transmission, powered by a constant-speed motor. Coal feed pipes 3½ in. in diameter convey the dried coal from the stoker-equipped fuel dryer, consisting of forced-draft fan and hot-gas piping, to the boiler stoker steel front plate, where the fuel is distributed evenly by spreader nozzles within the furnace.

The forced-draft fan for coal drying has furnace-connected hot-gas piping supplying inlet gases to the fan at 950 F. The dryer has adequate capacity to heat and dry coal containing 15 per cent moisture. Each boiler is equipped with an overfire air and fly-ash reinjection system, arranged so that the high-pressure blower and connected inlet and discharge piping collects and delivers fly ash from rear boiler passages to the combustion chamber for reburning.

A stoker fuel-feed controller directed by the master controller regulates rate of fuel feed to each furnace. Furnace air for fuel combustion is supplied by two forced-draft and one induced-draft fan for each boiler, and an air-flow controller regulates and maintains, through damper adjustment, a predetermined ratio of air to fuel fed into the boiler furnace. A furnace-draft controller automatically maintains furnace pressures varying from 0. to −5 in. wg in accordance with heating loads.

Induced-draft fan and stack units are designed to handle 42,500 lb of flue gas per hour up to 600 F. and have a capacity of 14,500 cfm at 4.88 in. water gage head. Each of the two forced-draft fans per boiler has a capacity of 5000 cfm at 2 in. wg, and is driven by a 1200-rpm, 440-v motor.

All electric motors are designed for 440-v, 3-phase, 60-cycle service. Motor starters are automatic across-the-line with under-voltage and over-load protection of the thermal relay type. An automatic air-puff soot blower system is installed on each boiler. A cycling controller operates the soot blower units on each boiler in a predetermined sequence, to provide sufficient capacity for complete soot removal per boiler every two hours.

Coal and Ash Handling

Coal handling equipment consists of a track hopper emptying onto a magnetic head pulley driven conveyor which feeds coal into the crusher having a capacity of 25 tons per hour. During this process, the coal can be reduced from 8-in. lumps to 1-in. lumps and is conveyed from the crusher to the 160-ton capacity bunker by a V-bucket elevator-conveyor. The coal crusher is driven by a 15-hp, 1800-rpm motor.

By-products of combustion are removed from the ash hoppers and dust collector hoppers by a mechanical exhauster pneumatic conveyor and deposited in a tile storage silo adjacent to the boiler house. All conveyor piping and fittings are special cast alloy, high-abrasion-resistant steel, fitted with easily-replaceable wear plates and slide gates for volume regulation. A cyclonic separator type ash receiver with swing-gate discharge box is mounted on top of the storage silo, and unloading is controlled by an automatic timer accessible from the boiler house.

An air washer of the cyclonic water spray type is installed in the ash conveyor system ahead of the exhauster, its operation automatically controlled by an ash receiver timer. A multistage centrifugal exhauster driven by a 25-hp electric motor completes the ash conveying system. The entire

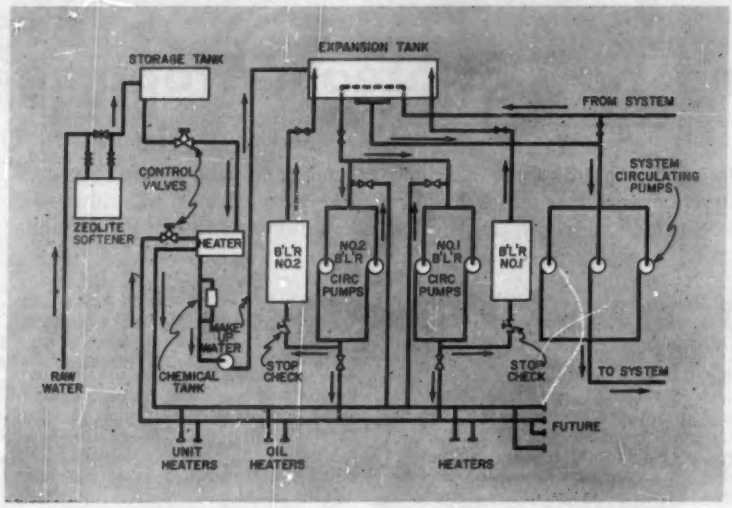


Fig. 2. Flow diagram of water circulation in boilers, heaters and pumps in h-p, h-t water boiler plant of Fig. 1

at the Naval Supply Depot

system has a capacity for removing five tons of ash per hour. The rotary type ash storage silo unloader is equipped with an automatic feed gate, rotating cylinder and water spray to dampen and mix ash. When mixing is completed, the batch is chuted into trucks.

Water System

Storage tank of 1500 gal capacity provides makeup water for the expansion tank and connected covered distribution lines. Prior to the heating cycle, water for boiler makeup feed purposes passes into a 750-gal hot-water heater wherein the feedwater temperature is raised to the range of 200 to 212 F. The feedwater heater is vented to atmosphere and provided with a level control for regulating intake water quantities. All makeup water is sodium zeolite softened. A chemical feed unit with an open top dissolving tank and removable basket is connected to a closed pressure tank for introducing chemicals to the makeup feed pump suction.

A reciprocating twin-cylinder makeup feedwater pump having a capacity of 20 gpm and discharge pressure of 400 psig, powered by a 20-hp motor, furnishes the expansion tank with water to compensate for system losses. The makeup feed pump and motor operation is automatically controlled by a high-low limit control in the expansion tank. Water loss in pumps, piping and approximately 11,000 ft of distribution mains is normally 50 to 60 gal per day.

Each boiler is provided with two variable-capacity centrifugal pumps for circulating water from the system return, through the boilers to the expansion tank. The system return pipe passes through the expansion tank and has perforations for equalizing the pressure between the two circulation cycles of the system. This allows some flexibility in quantity of water circulated to the distribution system as compared to the quantity of water circulated through the boilers. The boiler circulating pumps supply up to 350 gpm each at a discharge pressure of 95 ft head. Distribution system circulation is accomplished with two 400-gpm at 150 ft head and one 220-gpm at 172 ft head centrifugal pumps.

Controls for Water System

Each boiler is equipped with one temperature limit control for manual reset, one pressure differential control with valves, and dual pressure gage. The temperature limit control is connected to thermocouples installed in discharge and inlet headers of each boiler for automatically controlling the water temperature rise through the boiler cycle. Adjustments provide for cutting out the fuel and air when inlet and discharge water temperatures become equal.

Pressure controls are likewise installed in each boiler and function in parallel with the temperature controls; that is, when there is no pressure difference between the inlet and outlet headers, a cut-out occurs on the fuel and air control. In case the fuel and air cuts off, water circulation through the boilers continues at all times. Heat demand is controlled by thermometers in the system return and discharge side of the pumps to distribution, and is normally operated at a temperature drop of about 120 F.

Circulating boiler water is maintained at approximately 400 F. The Btu meter is designed to measure the total Btu input to the heating system and consists of a recording and integrating instrument for water flow temperatures to and from the distribution system. The recording charts and integrators are calibrated to read return and discharge temperature to distribution system, pounds per hour circulated and continuous Btu output per hour.

In some of the buildings throughout the distribution system, circulating hot water is used in heat exchangers to generate steam for conventional low-pressure heating.

Performance of Plant

One advantage of the high-temperature hot-water system is the heat-carrying capacity for great distances with a minimum of heat loss. Piping diameters for the high-temperature hot-water distribution system need be about one-half that required for steam, and makeup water is a negligible item. Compared with the conventional steam heating plant, it has been found that the boilers cannot be forced beyond their rated capacities. It is essential that all piping in the boilers and distribution system be manually vented at the high points and provided for draining at low points. In case a section of the heating system is cut out for maintenance or changes, it is necessary that the section be completely filled and vented before connecting with the main system.

Heating plant is constructed with steel-reinforced monolithic concrete frame and concrete block masonry walls. Reinforced concrete columns and beams support the similarly constructed floor and ceiling and imposed equipment loads. Windows and doors are steel framed and ladder stairs and catwalks are fitted with steel grating.

During the 1954–55 heating season, an active contract extending the heating mains to additional loads, with consequent variable heating demands, prevented accurately checking the economies accrued from this installation of high-pressure, high-temperature hot water generators in lieu of steam. However, no serious problems developed that adversely affected operations.

Plant designers were Adache and Case of Cleveland, Ohio, with Paul Gehringer of American Hydrotherm Corp. as consultant. Boilers were constructed by International Boiler Works and installed under the direction of the District Public Works Officer, Ninth Naval District. The plant is operated by the Naval Supply Depot under the command of Captain W. F. Prien.

The Why and How of Steam Trapping

This is the first of three articles explaining modern steam trap construction and operation. The remaining two articles will deal with trap selection, sizing, application, maintenance and trouble-shooting

1. TYPES OF TRAPS

By JOHN W. WELKER *

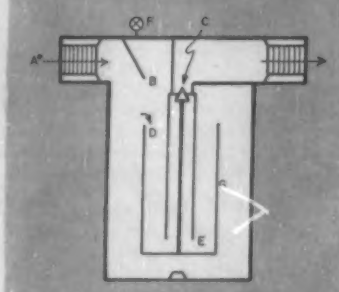


Fig. 1. Mechanical type trap of open top float or bucket design

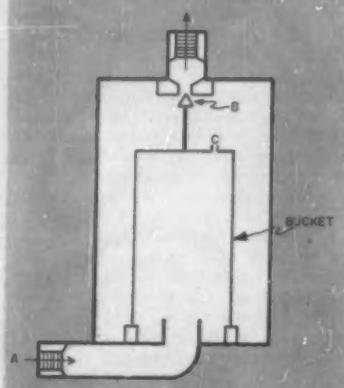


Fig. 2. Another type of mechanical trap. Inverted bucket design

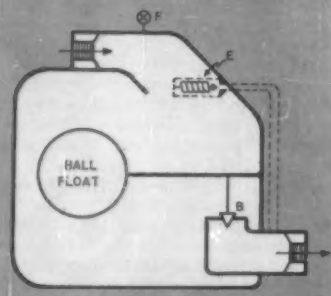


Fig. 3. Another mechanical type trap. Closed ball float design

MANY YEARS AGO steam was allowed to blow free to the atmosphere because it was inexpensive to produce. Later as costs became more of a factor, devices such as ordinary cocks or simple valves were used in an attempt to trap steam in process equipment, and at the same time to allow condensed steam (condensate) to escape. These devices were adjusted to function under average conditions, but could not be counted on to function unattended as desired under varying loads.

In this article we will give a brief description of the main types of steam trap in use today. They will not be in any particular chronological order.

A steam trap, by definition, is an automatic device for draining condensate and air from any space where steam is condensed. Steam condensing in heating equipment must be drained to maintain maximum heat transfer. Condensate in steam mains must be drained to prevent water hammer and other dangers created by slugs of water. Air must be eliminated to prevent dilution of steam, reduction of heat transfer, and in some cases corrosion. At the same time in any of the above cases steam should not be allowed to escape. A good trap meets all these requirements.

If condensate is allowed to remain in steam-heated equipment, the capacity of the equipment is reduced. Condensate by filling possible steam space acts as an insulator between steam and the material being heated, and has very little usable heat when it is compared to an equal weight of steam. Heat required to raise water to the boiling point is sensible heat; heat to change water to steam at the boiling temperature is latent heat.

This latent heat which is lost almost instantaneously when steam condenses, amounts to several times the sensible heat which is lost only slowly as water cools from the boiling point to a lower temperature. It is therefore desirable to eliminate condensate as soon as formed. At this point about 75 per cent of the usable heat has been lost, and condensate becomes a detriment to efficiency.

Traps can be placed into two basic and distinct classifications, namely, return and non-return. The return trap is complex, infrequently used, and very expensive when compared with a non-return trap; it is a trap which returns condensate against a pressure equal to or slightly higher than the pressure at which the condensate is delivered to the trap.

This article deals solely with non-return designs which discharge to pressures less than inlet pressures. A non-return trap does not initiate the action but allows steam pressure on trap inlet to force condensate and/or air through it to a disposal or return system, and at the same time it prevents escape of steam.

Non-return steam traps can be

*Application Engineer, Yarnall-Waring Company

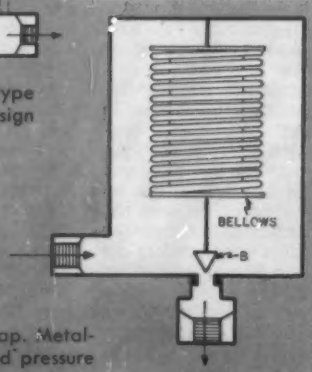


Fig. 4. Thermostatic trap. Metallic bellows or balanced pressure

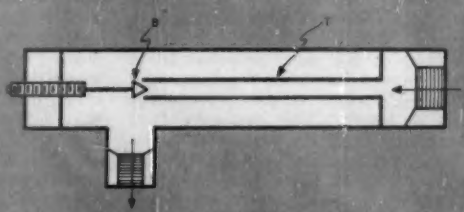


Fig. 5. Another thermostatic type trap. Metallic expansion design

grouped into three general types:

Mechanical (Open top float or bucket — Inverted Bucket — Closed ball float)

Thermostatic (Bellows — Metallic Expansion — Liquid Expansion)

Thermodynamic (Impulse — orifice)

There are certain combinations of these basic types. The following description of each type will provide a better understanding of how they are constructed and how each operates. Illustrations are diagrammatic, and in no way present details of design. They are used to illustrate in simple terms the basic design and operational characteristics.

Mechanical Traps

The mechanical trap differentiates between condensate and steam by virtue of the difference in weight between the two fluids.

Open Top Float, Bucket Type (Fig. 1)

Condensate flows into the trap at A, and is usually deflected downward by a baffle B. The body of the trap fills with condensate, and the empty bucket G is buoyant and floats upward closing the valve C. The bucket is now at its highest position and as additional condensate enters the trap it begins to spill over into the bucket at D. The bucket then fills to a point where it is no longer buoyant, and sinks, opening valve C. Steam pressure at A then forces the condensate out of the bucket through C. The bucket again becomes buoyant and rises before it is completely empty so that a water seal is maintained at E to prevent escape of steam. On start-up and frequently during operation this type of trap will become filled with air which must be released to permit sufficient condensate to enter trap to make it operate. An air release valve F, usually manually operated, is necessary. This valve is opened to purge air, but must be closed to prevent steam loss.

The discharge is intermittent and the trap cycles at intervals determined by the amount of condensate handled per unit time. The weight of the bucket, which is a constant, must oppose the force created by the valve seat area multiplied by the operating pressure. The weight of the bucket establishes one of two limiting possibilities — the maximum operating pressure for a given seat area, or the maximum valve area for a given operating pressure.

Inverted Bucket Design (Fig. 2)

On start-up, the open-bottomed bucket is resting on the bottom of the trap body which means that valve B is open. Condensate entering through A drives air out of body through B. Air in the bucket escapes upward through the fixed orifice C in the bucket top. After residual steam in the bucket condenses, condensate ultimately fills the trap body and bucket, and discharges through B. If steam reaches the trap it displaces the condensate in the bucket, and even though a small amount of steam escapes through C, the bucket becomes buoyant and valve B is closed.

As condensate follows, a point is again reached where buoyancy is lost, and valve B again opens to allow condensate discharge in cycles. The size of the orifice C determines at a given operating pressure the air handling capacity. Steam loss through this orifice is determined in an inverse fashion. In some designs this orifice is closed by a simple thermostatic element which must be sensitive to a small increment of temperature between hot condensate surrounding the bucket and steam temperature within. The weight of the bucket opens the trap valve B, and its buoyancy when filled with steam closes the valve. As with the open bucket, the area of valve and operating ratios are established by the weight of the bucket.

Closed Ball Float Design (Fig. 3)

At start-up the float is at its lowest position, and valve B is closed. If there is a lot of air in the system, a manual vent F must be opened to allow condensate to fill the trap. In some designs a thermostatic element such as shown dotted at E is incorporated to automatically vent air and close near steam temperature.

To prevent steam blow through the trap, valve B is usually covered by condensate before the float rises to open the valve. The float rises in proportion to the amount of condensate entering the trap, and so long as condensate flows to the trap, discharge is continuous. A ball float is sometimes guided so as to seal the valve itself, but most often it operates a lever system as shown. Closing power is a function of the weight of the float; opening power is a function of the buoyancy of the float combined with the mechanical advantage of the lever system when used. These factors combined determine capacity and operating pressure ranges.

Thermostatic Traps

The thermostatic trap differentiates between steam and condensate by virtue of the temperature difference between the two.

Metallic Bellows Design (Fig. 4)

This type, also called a balanced pressure trap, has a thin corrugated metallic bellows element which expands with changes in temperature. The bellows is sealed under vacuum and is partially filled with a mixture of water and a volatile liquid with a boiling point less than water. One end of the bellows is rigidly fixed to the trap body; the other end has the valve attached and is free to move. When cold, the bellows has a length permitting valve B to be open to pass air and condensate. As it becomes hotter the bellows lengthens, and finally at a temperature approaching that of steam the valve is closed.

Because of the lower boiling point of the mixture inside the bellows, a vapor pressure differential between inside and outside is established just before steam temperature is reached in trap body. The differential pressure causes expansion of the bellows and closes the valve to prevent escape of steam. Condensate in the trap must subcool to a temperature where internal vapor pressure no longer exists in the bellows before the trap will again open. Vapor pressure temperature curves for water and the mixture in the bellows are essentially

Fig. 6. Liquid-filled thermostatic type. Liquid expansion trap

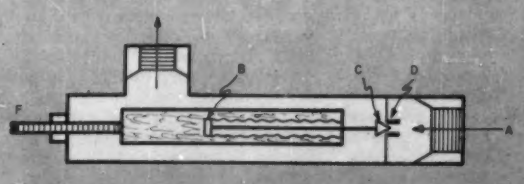
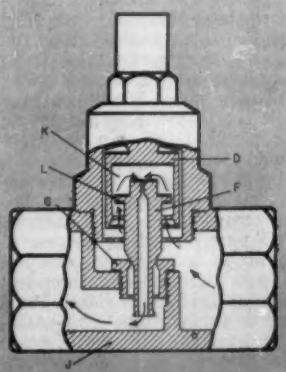


Fig. 7. Section through thermodynamic type trap. Impulse design



parallel. This fact insures a positive differential pressure available for closing the trap independent of the operating pressure.

Bellows traps are normally not recommended for superheat operation. Superheat creates excessive vapor pressure and tends to rupture the bellows. Discharge from a bellows trap is usually intermittent. Where condensate formation and temperature are constant, continuous flow can result.

Metallic Expansion Design (Fig. 5)

On start-up air passes through the valve B. Condensate follows and as it becomes hotter tube T (which forms a valve seat at one end) through which it is flowing, expands. This ultimately results in the seat being closed against the valve. The valve is adjustable to permit setting for closure just as steam temperature is reached. Such a trap has good characteristics so long as steam pressure is constant. If pressure increases, the trap will close prematurely because closing temperature will be lower than steam temperature unless the valve is reset for higher pressure (and temperature) conditions. If pressure decreases, the trap valve will not be closed when steam reaches the trap resulting in steam blow through the trap. In order to have appreciable expansion for valve movement, the metallic expansion tube must be long which results in an abnormally long trap. Discharge is continuous and at a set pressure, it can be set to discharge at any temperature up to steam temperature.

Liquid Expansion Design (Fig. 6)

This type consists of a liquid-filled thermostatic element which expands and contracts on a temperature difference between condensate and steam. Liquid is used to obtain greater expansion per degree of temperature difference; thus greater valve movement and a more compact design is achieved than with metallic expansion.

On start-up air passes through the trap followed by condensate. As condensate becomes hotter, the liquid in the thermostatic element expands. Piston B which is free to move slowly closes valve C against seat D as the liquid expands. The thermostatic element is on the outlet end of the trap valve, and as steam reaches here, the valve closes tightly. Gradually the element cools, contracts and opens the valve once more. It will continue to sample the medium entering at A; if steam is still at the trap the valve will immediately close, but if condensate is there it will stay open to a degree inversely proportional to condensate temperature. The adjustment at F permits setting the trap to operate at a definite temperature.

This type discharges continuously except under light load when it has a sampling or intermittent action. Capacity is determined by both steam pressure and condensate temperature. It will close at a temperature below 212 F (assuming atmospheric discharge). This is generally a disadvantage where condensate is to be discharged near steam temperature.

Such a trap cannot be installed near equipment being drained and still meet this requirement. A cooling leg must be provided between apparatus and trap to provide subcooling between the desirable condensate temperature and 212 F.

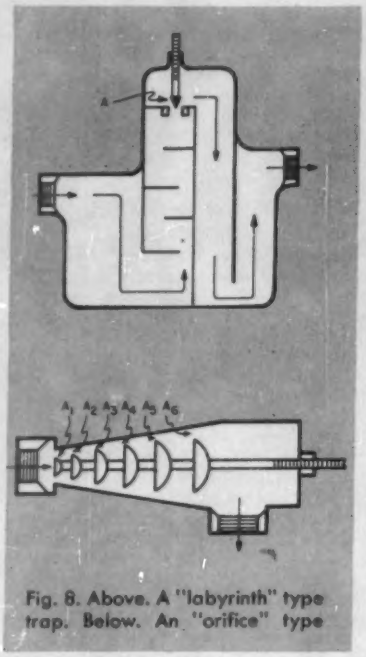


Fig. 8. Above. A "labyrinth" type trap. Below. An "orifice" type

Thermodynamic Traps

The operation of this type of trap depends on thermodynamic properties of hot condensate and/or steam as either or both pass through some form of orifice or orifices.

Impulse Design (Fig. 7)

Whether valve F is seated on G or open is determined by pressure in chamber K above disc L. In either position part, or (if valve is closed) all of the condensate passes upward through the annular space between disc L and tapered cylinder D into control chamber K. This portion of the condensate is known as the control flow, and the annular space is the first of the series of two orifices through which it passes. The second is the control orifice in the center of valve F. As condensate passes into chamber K and then through the control orifice into trap discharge, pressure is reduced. When hot water under pressure passes into a lower pressure it will flash to a greater or lesser degree depending on initial temperature and the pressure drop.

The degree of flash determines the pressure in chamber K; this pressure in turn determines whether valve F is seated or open. Cool condensate flashes little, chamber pressure is low, and the valve is open; this results in the trap floating on the load and passing cool condensate as fast as formed. The trap is designed so that condensate close to steam temperature will flash sufficiently to raise pressure in control chamber so as to exert sufficient differential pressure between top and bottom of disc to close valve before steam arrives at trap inlet. Control flow through the two orifices in series continues at all times and represents only a few per cent of total trap capacity. This flow makes the trap continuously and immediately responsive to slow or rapid changes in medium reaching trap.

This trap is ideally suited for removing the condensate immediately as formed, and thus results in keeping equipment up to highest temperature. It handles large amounts of air on start-up, and can be used without changing internal parts in the pressure range all the way up to maximum design pressure.

Orifice Design (Fig. 8)

These traps are often called "labyrinth" traps. To understand the operation of this kind of trap it must be remembered that for a given weight of steam the higher the pressure the less room it requires; thus if discharged to a lower pressure, it will expand. Similarly, if condensate at or near steam temperature and pressure is discharged to a lower pressure, a certain amount flashes into steam by virtue of an excess of sensible heat at the lower pressure. The closer the condensate is to steam temperature, the higher the percentage of a unit weight will flash. Any orifice placed in the flow path of condensate will tend to regulate flow in inverse relation to condensate temperature.

Fig. 8 shows two designs. In one there is a labyrinth followed by an adjustable orifice A; in the second there is a series of orifices a_1, a_2, a_3, a_4, a_5, a_6. The second design has an expansion chamber between each orifice. When steam is turned on, air "cascades" through the orifice series, taking a pressure drop at each stage, but eventually is discharged through the outlet. Cold condensate follows and also passes through. As the temperature rises, flashing begins at a point determined by not only temperature but also by clearances and expansion volumes. These last two factors are manually adjustable; if too wide open, no control is possible and even steam will pass through the trap. If the setting is too close, only cool condensate can pass. This design can be set to pass condensate just below steam temperature at a given pressure. At a given setting, if pressure drops, steam can pass; if pressure rises only condensate at a lower temperature can pass. Discharge is usually continuous so long as condensate reaches the trap. Condensate pressure and temperature control the operation. Only a manual change in setting can upset these relations.

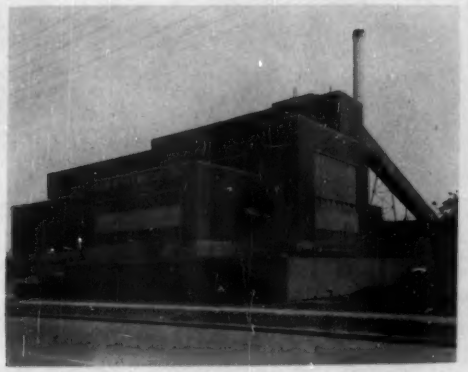


Fig. 1. Outside view of the new Kaw Power Station

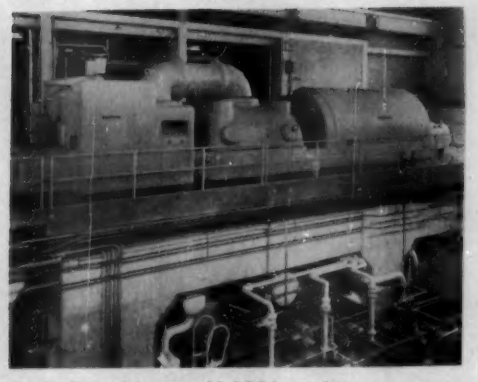


Fig. 2. One of the new 40,000 kw turbine generators

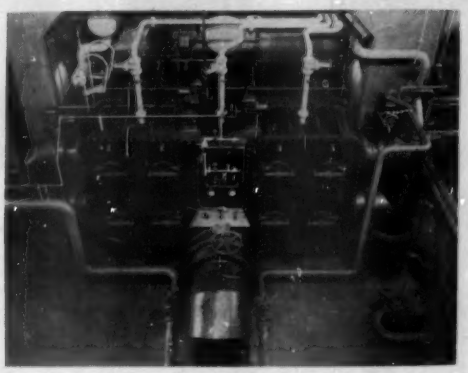


Fig. 3. Condenser is high point of circulating system

Kaw Station Adapts to Its Environment

50-ft river rise and fall at intake required a sealing weir in circulation system; Kansas River flooding necessitated a completely watertight basement, and reliability of modern switchgear helped make this an unusually compact station

MUCH OF THE business and industrial area and a large part of the residential area of Kansas City, Kansas, lies between the Missouri River, on the north, and the Kansas River, generally known as the Kaw, on the south. In the Kaw Valley an expanding industrial area required more power, and to meet this demand Kaw Power Station has been built by the Kansas City, Kansas Board of Public Utilities. Figs. 1, 2, and 3, show external and internal views of the station.

Location Difficulties

In locating the station on the Kaw River, in the midst of a growing industrial area, transmission and distribution problems were simplified, but water supply for the station was complicated by the peculiar characteristics of the Kaw River, whose level varies approximately 50 ft between high and low levels and whose minimum flow is about 300 cfs with a maximum which has exceeded 500,000 cfs.

A further complication was caused by the location of the station, which for various reasons had to be some distance from the river. The distance from the intake to the condensers is about 1100 ft and the effluent line is about 1300 ft long. The flow lines are of 72 in. concrete pipe, laid so the condenser is high point of the system.

The wide variation in river level between ordinary flows and flood flows made a sealing weir necessary. Fig. 4 shows diagrammatically the circulating water system, which shows the action of the weir in reducing the required pumping head by giving as much siphon action as possible.

River low level is approximately 722 ft. The sealing weir structure has an adjustable weir that may be adjusted from 736 to 743 ft to take advantage of as much siphon action as possible with different flows.

The circulating water system was designed to maintain a maximum vacuum of approximately 25 ft of water at the top of the condenser. This 25 ft vacuum is maintained by keeping the water level in the sealing weir approximately 25 ft below the top of the condenser. The circulating water pump has a head equal to the maximum static head plus the friction head. As shown in Fig. 4 the maximum static head is the difference between the water level in the sealing weir and the low water level in the river, or approximately 21 ft. The static head varies from 0 to 21 ft depending on river level.

Where the effluent line from the condenser enters the sealing weir a butterfly valve has been installed for priming the system on start up. The valve is remotely controlled from the control room and it has holes drilled through the disc so that flow cannot be stopped completely. By closing the valve, flow is restricted, allowing the circulating pumps to fill the system quicker and enabling the air to be evacuated faster for start up. A 20 hp vacuum pump is used to remove air from the system during operation.

A recirculating pump is located in the sealing weir so that a portion of the water can be returned to the intake through a 48 in. concrete pipe line. The warm recirculated water is delivered to the intake just ahead of the travelling screens, and it has been found helpful in reducing ice trouble.

Flood Protection

The top of the levee surrounding the station is 767 elevation. The power plant structure is water tight to elevation 773, and all pipes, drains, and conduits or cable are sealed to prevent flooding.

Figure 5 shows a sectional sketch of a water tight cable seal used in this plant. Conduits containing several cables of different sizes were sealed in the same manner as conduits containing one large cable. Empty conduits were closed with soil pipe test plugs.

The cable seals were installed as follows:

Dry oakum was packed around the cable to act as a dam to hold the in-

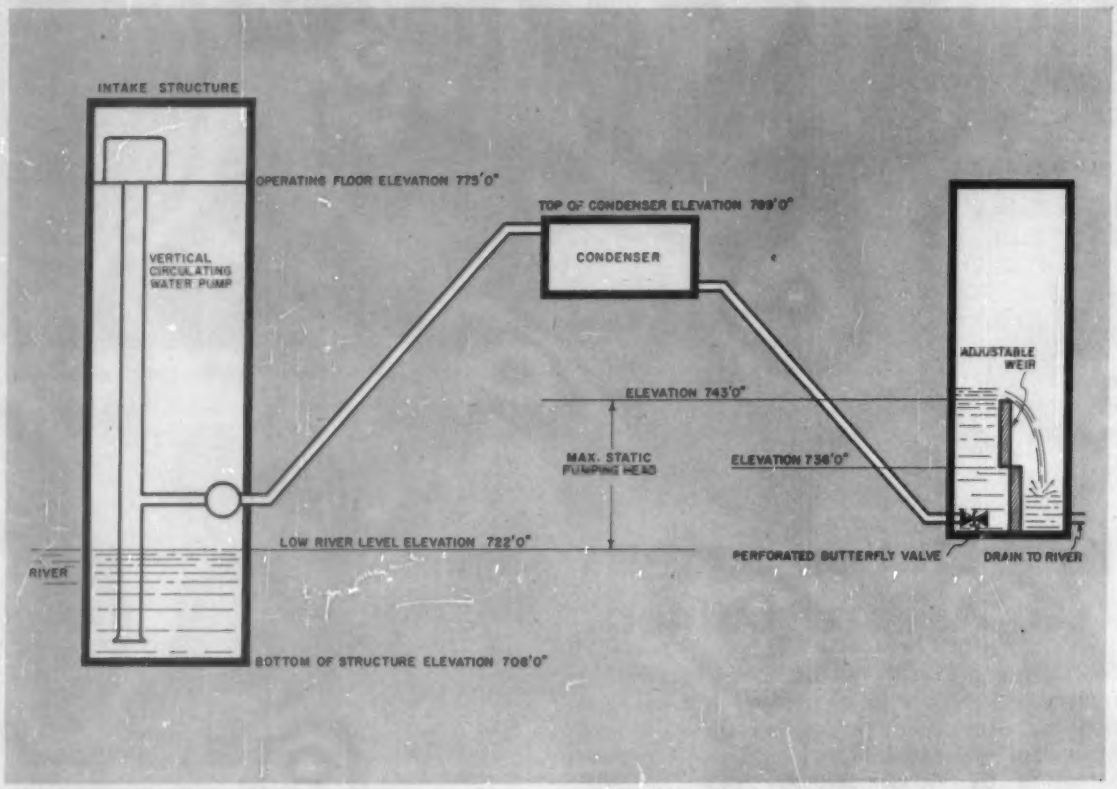


Fig. 4. Diagram of cooling water system. Large variation between normal and flood flows made sealing weir necessary

sulating compound. A wood block fastened to the cable was used to hold the compound at the bell and while it was poured. The compound was poured to a depth of four to six inches in the conduit. After the compound had hardened, the wood block was removed and the conduit packed with oakum. The oakum prevented the insulating compound from flowing when the fibre ducts were heated by the cables or ambient air.

This method is not felt to be the ultimate solution to the problem of providing water tight seals around cables in fibre conduits, though the seals have given satisfactory service so far. The insulating compound is difficult to hold unless the surrounding ambient temperature is low.

Duxseal, a plastic sealing compound, was used as additional waterproofing protection in conduits containing cables, in empty conduits containing fibre plugs, and for sealing fibre conduit terminations in each underground manhole. It was also used for seals external to the power plant and in effect it gives a double seal on all lines entering or leaving the power plant structure.

Unusual Electrical Items

Reliability of modern air blast circuit breakers has had an interesting and significant effect on this station's design. This reliability enabled the

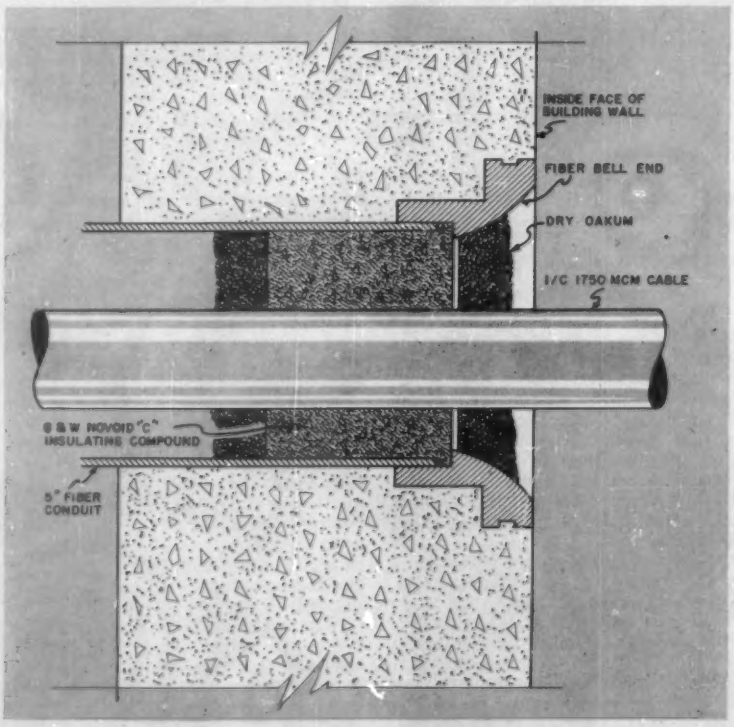
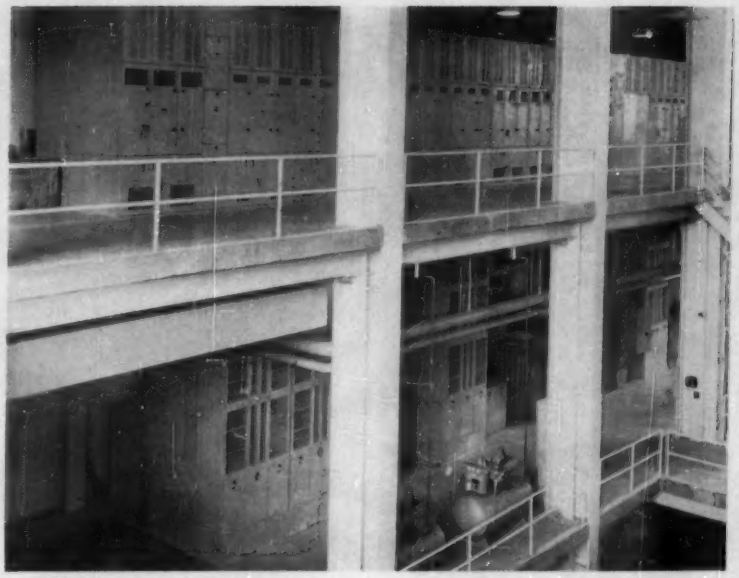


Fig. 5. Detail of watertight cable seal used as part of basement waterproofing

Fig. 6. Right. Compact arrangement with air-blast breakers, feeder reactors and outgoing disconnect switches on two floors instead of the usual three



station designers to choose a single bus, single circuit breaker arrangement for each generator, and also enabled the air blast breakers (1000 mva 13.8 kv), feeder reactors and outgoing disconnect switch and pothead compartments to be installed on two floors instead of the usual three. The air blast breakers are also left exposed on the operating floor instead of being isolated by a conventional wall between the bay containing the breakers and the turbine room proper. Figure 6 shows the compact arrangement of switchgear described above.

Engineers for the project were the Burns & McDonnell Engineering Company, of Kansas City, Missouri; Consulting Engineers for the Board of Public Utilities of Kansas City, Kansas.

Principal Equipment—Kaw Power Station—Kansas City, Kans.

Generating Unit and Auxiliaries:

One 40,000 kw, 3,600 rpm, steam turbine, 850 psi, 900 F, direct connected to 47,058 kva, 0.85 pf, 3 phase, 60 cycle, 13,800 volt hydrogen cooled generator, with turning gear, designed for 5 stages of feedwater heating and provided with direct connected exciter 155 kw, 250 volts and 2.5 kw, 250 volt pilot exciter. Westinghouse Electric Corp.
One 40,000 sq ft surface condenser, designed for reversing flow of circulating water, tubes 24 ft 0 in. length, and 1 in. OD 18 BWG. Two vertical condensate pumps, 800 gpm, 295 TDH, L.P. Heater in exhaust meck. Foster Wheeler Corporation.

Steam Generator and Auxiliaries:

One 400,000 lb/hr two-drum radiant boiler 875 psi, 910 F. heating surface 20,159 sq ft pendent superheater 11,212 sq ft, water cooled furnace — 6592 sq ft. Babcock & Wilcox Company.
Air heater — regenerative type — 68,300 sq ft. Lungstrom.
Three pulverisers table type feeders. Babcock & Wilcox Company.
Submerged type Attemperator. Babcock & Wilcox Company.
Ash hopper. United Conveyor.
One primary air fan. American Blower Corporation.
Six forced draft circular burners for gas, pulverized coal, or oil. Babcock & Wilcox Company.
Two forced draft fans — vane control. Green Fuel Economizer.
Two induced draft fans — inlet louver control. Green Fuel Economizer.
Fly ash collector. Aerotec Corporation.
Automatic Air-puff soot blowers. Diamond.
Compressors. Worthington.
Receivers. Babcock & Wilcox Co.
Setting for outdoor service — Fans and drive for outdoor service — Combustion Control. Dailey.
Steel Stack 10 ft diameter x 200 ft high. Darby.

Feedwater System:

3 — 500 gpm, 2780 ft TDH, 3575 rpm double cased with 450 hp motor drive — with one spare rotor. Byron-Jackson Company.
Demineraliser 2 — 16 gpm units (sized for two generators). Permutit Company.
3 — Feedwater heaters closed type. Griscom Russell.
1 — Deserating heater — 400,000 lb/hr. Cochrane Corporation.
2 — Condensate transfer pumps 450 gpm 200 ft TDH Fairbanks Morse.
2 — Condensate storage tanks — 75,000 gallons each. Darby.

Coal Handling:

Capacity 300 tons per hour (for ultimate generating capacity)
Yard storage 80,000 tons. Harry Surface Company.
2 sets of 4 thawing pits. Hauck Manufacturing Co.
1 — 14 ft x 28 ft Receiving Track Hopper.
1 — 16 ft x 16 ft Reclaim hopper.
3 — Coal hoppers are provided for each boiler — capacity 220 tons each.
Crusher. Penn Crusher Company.
Magnetic Separating Pulley. Dings.
30 in. Belt conveyors. Goodyear.
Continuous Weighing. Fairbanks Morse.
Telescopic Chute to yard storage. Webster.
Coal Sampling equipment. Geary-Jennings.
Conveying Equipment. Webster.
Dust control system. Johnson-March Corporation.
Trackmobile for moving cars. Whiting Corporation.

Circulating Water Facilities:

Intake structure — capacity 100 mgd.
1 — 15 ton locomotive type crane gasoline driven 30 ft boom. American.
2 — Traveling Screens. Link Belt.
2 — Vertical Pumps: 1 — 20,000 gpm and 1 — 40,000 gpm. Peerless.
1 — Vertical Pump 18,000 gpm (Recirculating pump). Peerless.
Sealing Weir structure and outlet (designed for ultimate capacity).
Concrete Pipe — 36 in., 48 in., 72 in. and 84 in. Lock Joint Pipe Company.
Butterfly Valves. Henry Pratt.
A 40,000 gpm pump and a traveling screen will be required for the second generating unit.
Additional intake and circulating water lines required for third and fourth units sized to suit conditions at that time.

Ash Handling:

Slag tank clinker crusher, eductor and transport system. United Conveyor Corporation.
Fly Ash evactor and transport system. United Conveyor Corporation.
Pyrites hoppers and transport system for each pulverizer. United Conveyor Corporation.
Concrete Ash and Slag Tank.
Grab Bucket Crane for removal of ash from tank. Milwaukee Crane & Service Co.

Railroad Facilities:

Approximately 6100 ft of track — can handle 30 cars per day.

Buildings:

Power plant building — Steel frame on concrete. S. Patti Construction.
Substructure and brick walls (Space for second generating units).
Piling — Cast in place. Raymond.
Crane — 100 ton main hoist, 25 ton auxiliary hoist. Shaw Box.
Package type boiler for emergency heating — 5600 lb/hr. Designed for gas or oil firing. Dutton.
2 — 12,000 gallon fuel oil tanks. Darby.
Office and control rooms air conditioned. Elevator service for boiler room. Montgomery.

Electrical:

Switchgear — 10 — 13,800 volt cubicles — generator feeders, tie feeder, station service, etc. 5 — Reactors, 250 volt d-c excitation, station battery and charger, 3 — 2500 kw 2400 volt power centers, 2 — 750 kw 480 volt power centers, busway and control room switchboard. Westinghouse.
Transformer — 1 — three phase 20,000/33,333 kvs tap changing under load 67,000/14,200 volt transformer to connect to overhead 69 kv tie line to Muncie Substation and Quindaro Power Plant. Moloney.
Communication System: An automatic interplant communication system connects the Quindaro Power Station, the Muncie Substation, and the Kaw Power Station. There are 10 desk sets at Kaw Station, 1 at Quindaro, and 1 at Muncie. There are 11 wall type and 2 outdoor type telephone sets. Some stations are arranged for conference talking. Some are arranged for talking on public address system. Automatic Electric Co.
Load Indication: A cable is run through the underground conduit system between the Quindaro and Kaw Stations and instrument provided to indicate the load carried by each of the power plants as well as the total system load at all times. Leeds & Northrup Company.

Power Engineering handbook

The Gas Turbine Primer

Part III

PARTS I AND II of this primer discussed the basic components that go into gas turbines and, necessarily, discussed the basic cycles for converting fuel energy into mechanical energy. It is left to Part III (the conclusion) to consider the many ways conceived to harvest the heat energy left over after mechanical energy has been removed.

When an engineer discovers how much heat is blown out the exhaust pipe of a gas turbine, something snaps. He immediately makes plans to put that heat to work. To an engineer, this windfall energy is as tantalizing as money left over from the budget is to the housewife. As a result, many ideas have been dreamed up to use the heat — and some of them make sense.

Heat is only one bonus the gas turbine has to offer; there is also about 80 per cent of the original oxygen left in the exhaust. This immediately suggests that more fuel could be burned, and the air is even preheated. With a start like this, it is not surprising that the "supercharged" boiler furnace was developed quite early. In such systems, a gas turbine is added to a steam power plant so that the exhaust of the gas turbine can supply combustion air to the boiler.

Figure 25 shows a supercharged furnace with a gas turbine that generates no electrical power but puts its total mechanical output into the forced draft fan. The blower output is preheated by the flue gases leaving the furnace, then the preheated air and gas turbine exhaust are blended before entering the furnace. Several advantages are obtained by this arrangement: The forced draft fan is smaller than one which supplies all the combustion air (it is supplemented by the turbine exhaust); the turbine exhaust heat is recovered; the blower can be started up even when all steam and electric power have been lost through total shutdown; and, higher rpm obtainable with the turbine permits the use of smaller, higher-speed blowers without step-up gears.

Figure 26 shows a variation of this idea. In this case, the gas turbine is not connected to a mechanical load but is used only as a gas generator. This gas powers a flue gas ejector, which replaces the induced draft fan. It is not an especially good application since — in order to recover the exhaust heat — the ejector must be placed ahead of the economizer and air preheater in the flue gas circuit. That means that the ejector will be pumping a much larger volume of gas than it would if the gas were cooler, and this is not an economical procedure.

Steam/Gas Turbine Cycle

Figure 27 makes much more sense. This shows a gas turbine driving a generator and supercharging a conventional boiler with its exhaust gas. The boiler supplies a steam turbine, and the steam condensate is used to intercool the gas turbine's air compressor. Compressor heat is largely transferred to the steam cycle (condensate) to reduce the compressor power requirement while slightly reducing the steam cycle fuel requirements. But the main benefit to the combined cycle results from the use of gas turbine exhaust in the boiler furnace or, in some cases, in feedwater heaters.

In a steam plant, adding a gas turbine to supercharge the furnace can add about 5 per cent to the efficiency the steam plant attained alone. This is also a good way to add economical generating capacity since the inexpensive simple cycle gas turbine can be used. Finally, this capacity can be put on the line very rapidly in an emergency and/or after a complete shutdown.

The cycle shown in Fig. 27 burns additional fuel in the boiler furnace, but some installations use only the heat remaining in the gas turbine exhaust to generate steam. These cycles are not used where high steam capacity is important since the exhaust will generate only about one kilowatt in the steam turbine for each 1½ gas turbine kilowatt. Where additional fuel is burned, the proportions are drastically reversed: From four to nine *steam* turbine kilowatts are generated for each gas turbine kilowatt, and with about the same flue gas losses. Furthermore, burning additional fuel means that the total plant output can be varied more easily to meet varying loads on either the steam or electrical phase, and higher steam pressures and temperatures can be utilized.

Effect on Small Plants

An important thing to remember about these combined cycles is that addition of a gas turbine to small plants can give those plants overall efficiencies comparable to those obtained in the best of the large plants. In many cases, a

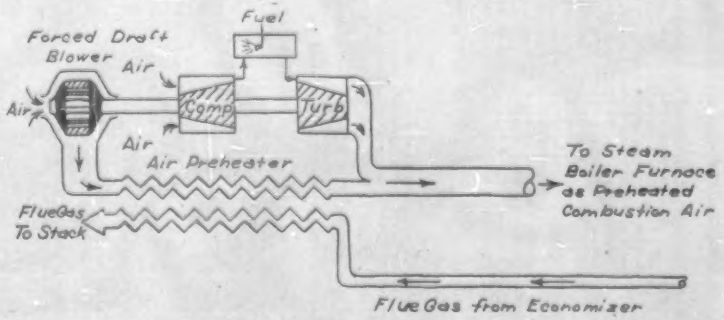


Fig. 25

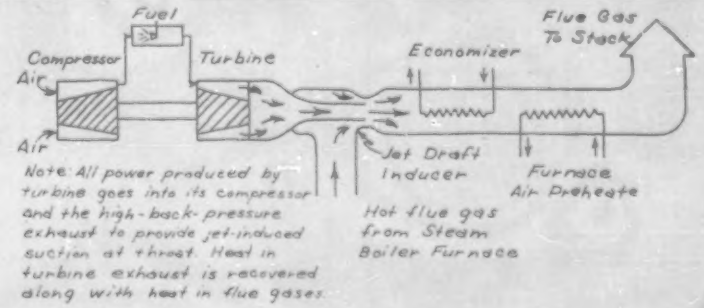

Fuel
Compressor Air
Air
Turbine
Economizer
Flue Gas To Stack
Jet Draft Inducer
Furnace Air Preheate
Note: All power produced by turbine goes into its compressor and the high-back-pressure exhaust to provide jet-induced suction at throat. Heat in turbine exhaust is recovered along with heat in flue gases.
Hot flue gas from Steam Boiler Furnace

Fig 26

fold along this line—outside edges toward you

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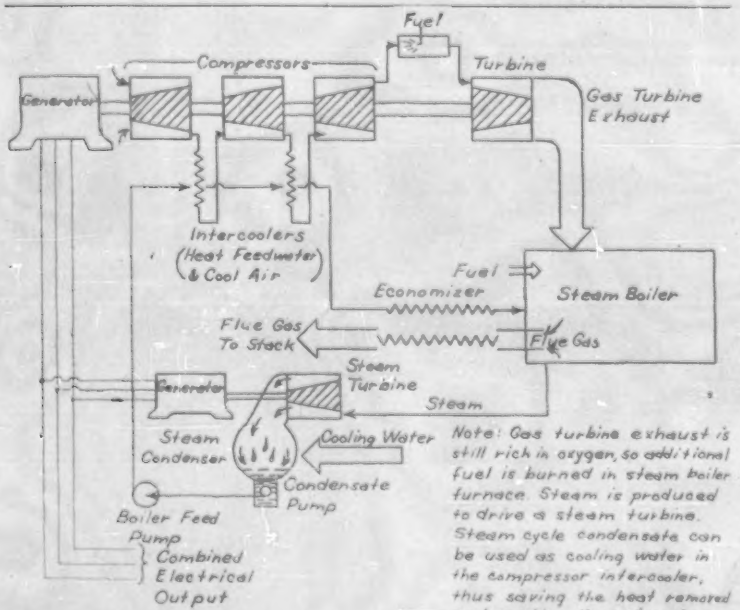
Fuel
Compressors
Turbine
Generator
Gas Turbine Exhaust
Intercoolers (Heat Feedwater & Cool Air
Fuel
Economizer
Steam Boiler
Flue Gas To Stack
Flue Gas
Steam Turbine
Generator
Steam
Steam Condenser
Cooling Water
Condensate Pump
Boiler Feed Pump
Combined Electrical Output
Note: Gas turbine exhaust is still rich in oxygen, so additional fuel is burned in steam boiler furnace. Steam is produced to drive a steam turbine. Steam cycle condensate can be used as cooling water in the compressor intercooler, thus saving the heat removed and putting it in the steam cycle. No forced-draft fans are needed on boiler furnace since gas turbine back-pressure can perform this function.
Note: Appropriate switchgear would separate the two electrical generators so either can operate independent of the other.

Fig. 27

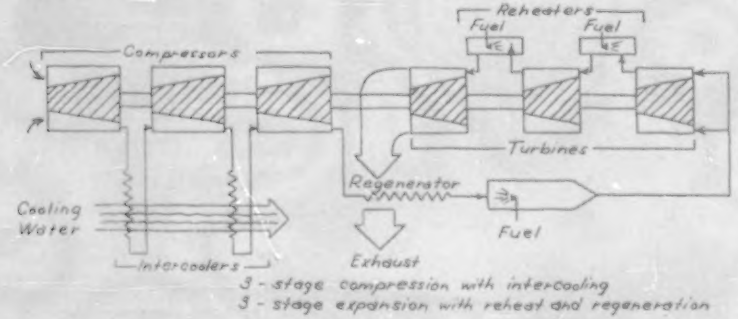

Fig. 28

fold along this line—ouside edges toward you

50,000-kw combined plant will have a better utilization of fuel than 150,-200,000-kw steam plants operating with reheat and at a higher pressure.

Older plants with lagging efficiencies can often be brought up to system performance by supercharging with added gas turbines. Few alterations need be made in the older steam plant to utilize the gas turbine exhaust or the extra electrical output. In these cases, it would be wise to leave the old forced draft fans on a standby basis so that the steam and gas turbines can operate without one another in the event of an outage. It would cost practically nothing for this extra margin of safety.

Some additional arrangements not illustrated here should be noted, for each has its individual merits. First is the gas turbine-driven boiler feed pump. In this case, the exhaust would go direct to the boiler furnace where it would be supplemented by forced draft fans. Super-pressure plants would find this arrangement desirable because the gas turbine could drive a centrifugal type boiler feed pump fast enough to develop the high pressure without the large-diameter impellers otherwise required.

Some stoker coals cannot tolerate too much preheat in the combustion air, so a gas turbine would put some of the exhaust heat into preheating its own combustion air. Exhaust gas leaving the regenerator would still have enough heat to materially boost furnace combustion — and exhausts from regenerated cycles would have somewhat higher oxygen content than unregenerated cycles.

Station electrical loads could be supplied by a supercharging gas turbine, even where the turbine's exhaust would supply only a small part of the combustion air. Its advantages would still accrue to the cycle, and it would be a great help in starting up a cold plant.

Finally, even in steam/gas turbine plants it is not always best to use the gas turbine exhaust to supercharge the boiler. This would be the case where boiler capacity limits the station generating capacity. The exhaust gas could be better used here to heat feedwater and thus boost the steaming capacity of the undersized boiler. Where the steam turbine is the limiting factor, the exhaust is better used as combustion air. Remember that the object of any cycle we might conceive is the generation of power at the least total cost per kilowatt. Putting the exhaust into feedwater heaters will not boost station efficiency as much as supercharging the boiler, but it will lower the fixed cost per kilowatt capacity and still help efficiency some.

Gas Turbine Reheat

Those familiar with the principles of *reheat* in steam cycles will not be surprised to learn that substantially the same thing can be practiced in the gas turbine. This involves expanding the gas through several turbines and burning additional fuel in the oxygen-rich gas between stages. Figure 28 illustrates how this can be done.

Reheat increases the mechanical work done by a given quantity of air. Since the compression of air accounts for much of the internal work of a turbine, it seems that higher cycle efficiency would follow. Of course, it is not that simple. Reheat greatly increases the amount of heat in the exhaust, so reheat alone can do some very bad things to the cycle efficiency. So why do it?

A gas turbine of given size will generate more mechanical power with reheat than without it. Also, if the exhaust heat is partially reclaimed in a regenerator or a steam boiler, the cycle efficiency will be improved. Hence, the cost per kilowatt capacity of the gas turbine will be less and the operating efficiency will be higher — a combination hard to beat.

Reheat reduces the amount of unused oxygen in the exhaust, however, so the amount of fuel that can be burned in a superimposed boiler is less. If the steam phase were to burn no fuel anyway, and merely be a waste heat reclaimer, there is an advantage to burning all fuel possible within the turbine.

Coal Burning Turbines

Coal burning, mentioned in Part I, has many economic advantages over oil or gas burning in the larger part of this country. For that reason (and few others) coal burning gas turbines are very attractive to stationary power plants. Low plant costs and low fuel costs are desirable, to say the least.

Figures 29 and 30 show two approaches to this problem, both of which show promise. The first calls for a spreader stoker which operates under the maximum cycle pressure. Coal must

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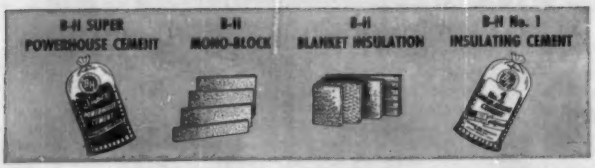

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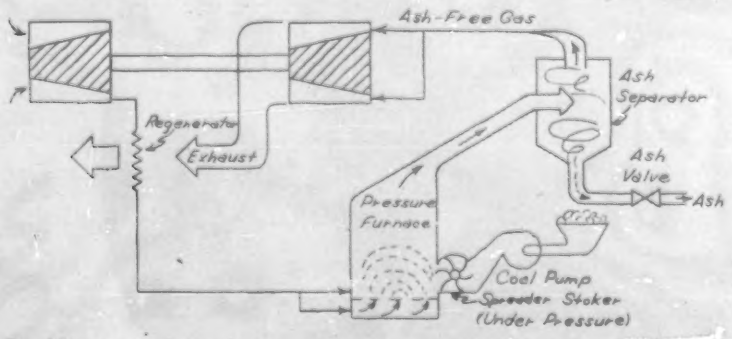


Fig. 29

be "pumped" into the stoker in a manner which will prevent air leakage, but once inside it can be burned with a very high heat release-to-furnace volume ratio. The main problem, as in the locomotive gas turbine, is the removal of ash before it can erode the turbine blades. This unit is being developed overseas at this time.

The second approach calls for a large heat exchanger (Fig. 30) in which fresh, compressed air is heated to maximum cycle temperature. The turbine exhausts hot *fresh* air into a furnace where coal is burned. Such an arrangement requires less stringent ash removal than the previous cycle because the products of combustion go directly to atmosphere. The cycle, called the *exhaust heated turbine*, was developed expressly for burning coal, but Fig. 31 shows how it could be used to burn low-grade fuel oils without damaging the turbine.

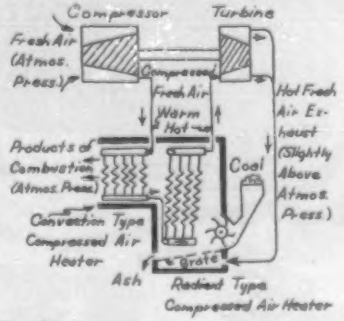


Fig. 30

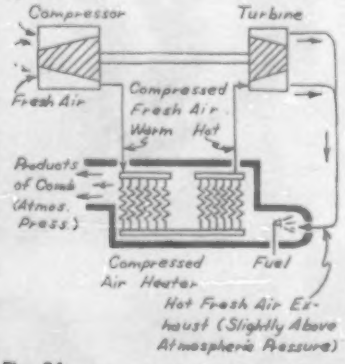


Fig. 31

Closed Cycle Turbines

Cycles shown in Figs. 30 and 31 require a large gas-to-air heat exchanger which some call an "air boiler." It is very similar to a regenerator, but operates at higher temperatures and may even have a radiant heat section like those found in many boilers. These cycles are open cycles, in a sense, because the combustion air passes through the compression expansion cycle and exhausts ultimately to the atmosphere.

Closed cycles (Fig. 32) utilize an air boiler similar to those used in exhaust-heated cycles, but the air inside the power cycle is never used to burn fuel. The turbine exhaust is cooled, recompressed, reheated, and re-expanded continuously. Combustion air (in this cycle) is supplied by a forced draft fan, which is driven by a small auxiliary turbine.

Since the cycle air is not used to burn fuel, it might be replaced by some other gas. Even if air is used, however, it need not be at atmospheric pressure at any point in the cycle. Maintaining high pressures throughout the cycle means that the circulating gas will be much more dense than in open cycle machines and the denser air permits reduction of the machine size for a given power output. Much greater pressure drops are possible, of course, if the top pressure is 900 psi than if it were only 100 psi; and the air density at the lowest point could still be higher than the maximum density in the open cycle machines.

Closed cycle gas turbines offer the greatest possibilities for really large units. One is now operating in Europe that is rated at 27,000 kw with 34 per cent efficiency. Not only do the closed cycle plants offer the best prospects for large units, they offer the best possibilities for burning coal. No ash enters the circulating gas.

There seems to be an excellent opportunity for someone to combine an open-cycle gas turbine with a larger closed cycle unit to the advantage of both. This would be very similar to the supercharged steam boiler application and corresponding gains in efficiency could

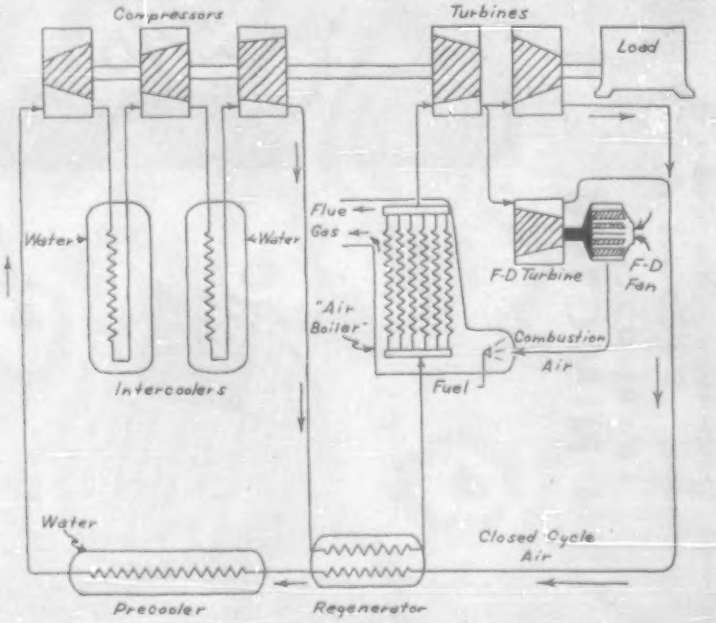
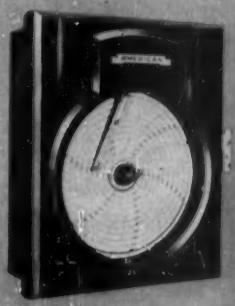


Fig. 32

DIAL THERMOMETERS



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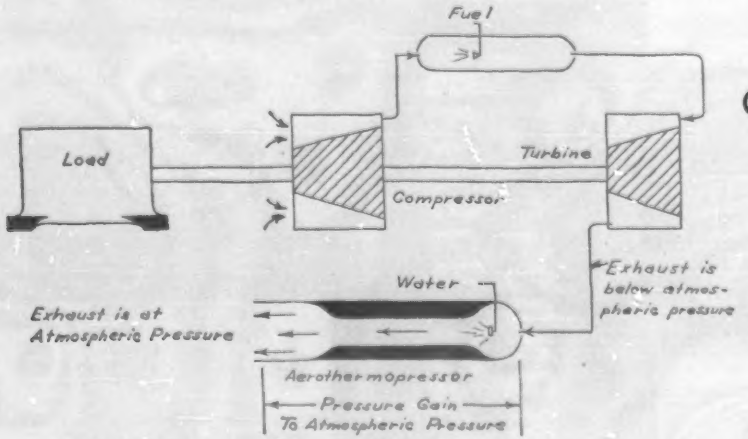


Note: Injecting water into a properly-shaped exhaust assembly converts some of the exhaust heat energy into extra velocity head. Since the only counterforce is atmospheric pressure, the velocity head gain is balanced by the pulling of a partial vacuum in the turbine exhaust. This increases the pressure drop across the turbine, and the power output increases with no increase in fuel consumption. Hence, a gain in both power output and effiency

Fig. 33

be obtained. With or without supercharging, however, it must be remembered that closed cycle plants must have quite a bit of cooling water — and the plants are no longer simple. Hence, two of the main reasons for installing gas turbines are weakened.

As in open cycle units, the advantages of reheat apply to closed cycles. Figure 32 does not show reheat, but if it were added between the two main turbine wheels the capacity of the entire unit would go up. This could be accomplished by running the first turbine exhaust back through the air boiler, just like a steam reheat layout.

Aerothermopressors

Aerothermopressors are more than a one-word spelling bee. They approach the problem of boosting output and efficiency in a most unusual manner. Rather than putting the exhaust heat into a boiler or back into the compressed air supply, turbines using these devices actually pull a partial vacuum on the turbine exhaust — increasing the pressure drop across the turbine — and use the exhaust heat to do it.

This begins to sound like a boot-strap operation, but it makes sense. Water is injected into the exhaust stream in a specially shaped venturi duct. The water evaporates and expands in the direction in which the gas is flowing, thus increasing the momentum of the flow. Since the only thing opposing the flow momentum is atmospheric pressure and friction along the tailpipe, the forces are balanced by a reduction in pressure at the turbine outlet. The difference in pressures (static pressures) is made up by the momentum gain and this, in turn, is caused by accelerating the exhaust and adding to its weight.

Except for some experimental devices, no practical applications have yet been made of the aerothermopressor. Figure 33, however, shows how it would look installed in a simple cycle turbine exhaust. The long throat in the venturi allows time and space for the water droplets to evaporate and add to the acceleration of the exhaust.

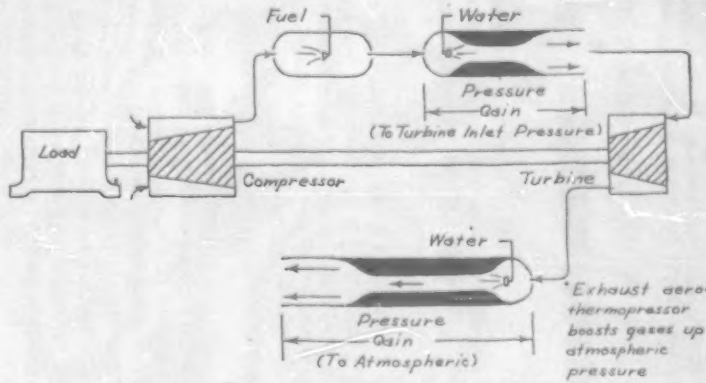
Using the heat of the exhaust to eject itself from the tailpipe has the following effects: Less air is used by the turbine per horsepower developed; less fuel is burned to produce a given amount of power; the possible power output of a given turbine is increased; the best compression ratio is lower; the entire cycle is less sensitive to load and air temperature changes. Water requirements run about ¼ pound of water per pound of air circulated.

Figure 34 shows a variation of this idea. In this case, water is injected ahead of the turbine to boost turbine inlet pressure above the compressor discharge pressure. Also, another aerothermopressor is installed in the exhaust to lower the turbine outlet pressure. Hence, the turbine is operating with a much higher pressure drop (and developing much more power) than it could as a simple cycle. This arrangement has several effects: More fuel can be burned in the available air supply without exceeding a fixed maximum permissible temperature; the weight of gas (plus vapor) going through the turbine is increased; turbine power will be markedly increased; excess air will be greatly decreased; and, fuel consumption will drop. Another result worth mentioning is that the cost per kilowatt will drop greatly since the extra power is added at a relatively small cost compared with the cost of building the turbine bigger.

Aerothermopressors do not produce the efficiency gain that regenerators afford, but they add to capacity where regenerators reduce the output of a given turbine. Also, aerothermopressors are much more compact than regenerators and much less expensive.

Undoubtedly, a more pronounceable name would benefit the aerothermopressor more than anything else that could be done for it at this time. Should we call it a pressure jack?

The exhaust of turbines equipped



Note: Two "aerothermopressors" combine to increase turbine inlet pressure and decrease turbine outlet pressure. Hence, a double-barreled gain in pressure drop across the turbine without increasing fuel consumption.

Fig. 34

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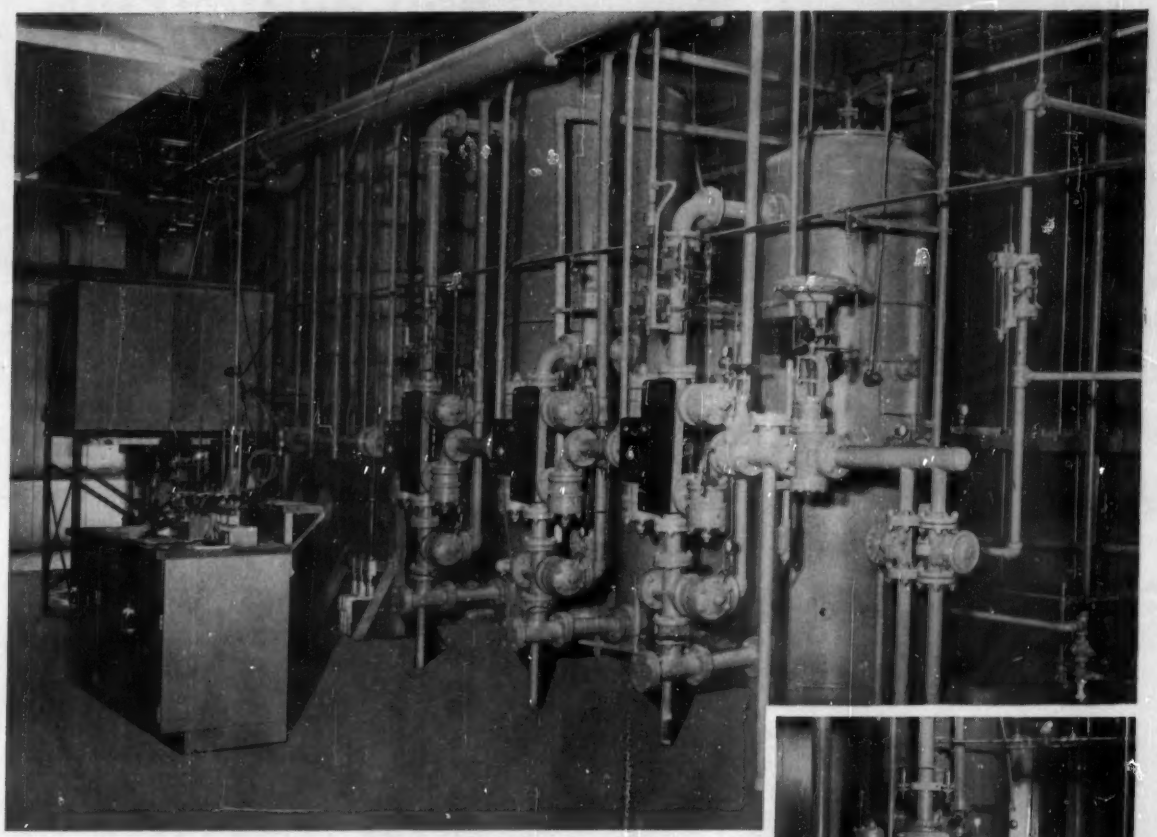
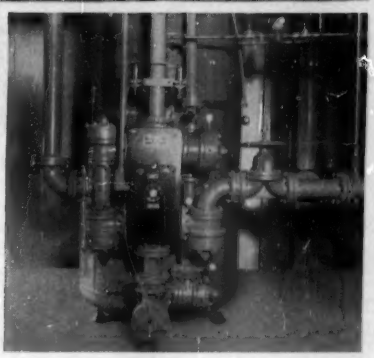


INFILCO Demineralization Plant installed at the North Omaha Station.



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with aerothermopressors would be less suitable for supercharging furnaces than would the exhaust from straight simple cycle or regenerated cycle machines. The reason is that the exhaust is saturated with water vapor and would limit the amount of heat that could be recovered from the flue gas; the dew point would be too high.

Emergency Power

Emergency power is normally thought of as generating capacity that is used only in time of crisis, when normal sources of power are disrupted. The mobile, emergency gas turbine plant offers an alternative to this restricted interpretation, but it has been surprisingly little investigated. The alternative is to have a mobile unit — a simple cycle unit — normally assigned to one of the stationary steam plants on the network where it would supercharge a boiler.

When disaster struck some part of the network, the mobile unit would be "detached" from the steam plant and dispatched to the disaster area. On emergency service, the unit would operate with the relatively low efficiency of the simple cycle. On normal service, it would boost the steam plant overall efficiency with its exhaust. A simple modification of the forced draft fan ductwork would permit running the steam plant either with or without the gas turbine by extending a closable duct out to a convenient railroad siding. The mobile unit would normally be parked on this siding and discharge its exhaust into the alternate duct.

This is a rather elaborate arrangement but it permits capitalizing emergency equipment on the same basis as operating equipment. A 5500-kw mobile unit could supercharge a 30,000-kw boiler furnace, and many plants in this size category need that 5 per cent efficiency boost.

P-V and T-S Diagrams

Until now we have considered the gas turbines and their cycles in general terms and without the formalized diagrams engineers are so fond of. Since this is not a textbook treatment of the subject, we will still forego the mathematics. It would be wise to look at the much-favored diagrams, however, since they explain what happens to the energy entering and cycling through the turbine. Since the three most promising (and, therefore, common) cycles are the simple cycle, intercooled-regenerative cycle, and intercooled-regenerated-reheat cycle, the diagrams shown will be limited to these.

In Figures 35–37, pressure is plotted against the air and gas volume as the air and gas pass through each cycle. The lower diagram plots the air and gas temperature against the entropy of the mixtures. These diagrams are called P-V and T-S diagrams, respectively.

The simple cycle (Fig. 35) takes in air at (1) and compresses it as efficiently as possible up to a pressure and volume represented by point (2). The less heating that occurs during this compression, the lower will be the volume at the point (2) pressure. The shaded area in the compression work diagram is proportional to the amount of work required to compress a given amount of air from (1) to (2). Less heating during compression reduces volume at point (2) and moves the entire curve between points (1) and (2) to the left, thus reducing the shaded area. This means that for less heating during compression, less compressor power is required. The temperature-entropy diagram at the bottom of Fig. 35 shows this in a different way; best compression would make the (1)–(2) curve straight up instead of sloping to the right, and the cycle net work area would be greater.

Power derived from the expander (turbine) is shown in the second diagram from the top. Air enters the combustion chamber at point (2) and is expanded at constant pressure from (2) to (3) by burning fuel. At this point it enters the turbine. The hot gas expands to atmospheric pressure at point (4). The hot exhaust gas has a much greater volume than the air inducted at point (1), and the heat wasted is represented by the area (1, 4, c, d). Area (1, d, 0, a) is not considered wasted since this represents the energy in the air originally and which was not added by the fuel.

P-V diagrams show very graphically why the gas can produce no more mechanical power beyond point (4). The gas is at atmospheric pressure and can push out no harder than the outside air is pushing back in. The aerothermopressor discussed earlier, despite its name, effectively lowers the pressure against which the gas is expanding and permits further mechanical action by that gas. Hence, more mechanical power

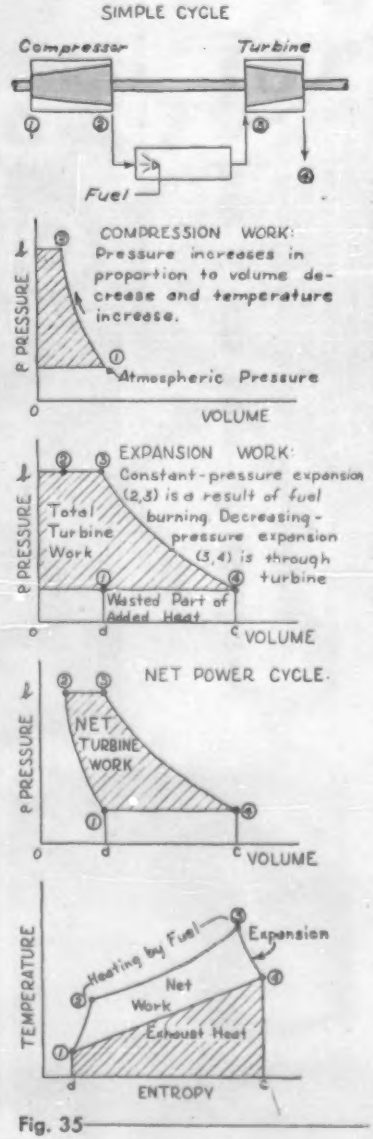

Fig. 35

is derived from the same amount of gas and fuel.

When the power required for compressing the air supply is subtracted from the total turbine power, the net turbine work is the remainder (neglecting other losses). When this is done with the diagrams of Fig. 35, we end up with the "Net Power Cycle" diagram shown third from the top. This is the traditional presentation of the pressure-volume relationship for gas turbines; it assumes that everyone knows that the compressor power is to the left of curve (1, 2) and that the total turbine output is everything to the left of curve (3, 4). Since it does not make much difference whether everyone knows this or not, the assumption has not been challenged.

At the bottom of Fig. 35 you will find a temperature-entropy (T-S) diagram. The fact that no one has come up with a really satisfying definition of *entropy* does not decrease the usefulness of T-S diagrams. Usually engineers deal in terms of *change*-in-entropy since this is the real source of significance of the term. For our purposes, entropy is merely a scale on the T-S diagram and it is expressed in Btu per pound per degree Fahrenheit. When the entropy change is multiplied by the temperature change as a gas changes from one condition to another, the "area" (at least it is an area on the diagram) is in terms of Btu per pound of the gas.

The simple cycle T-S diagram shows the compression line (1, 2) sloping up to the right. Ideal compression would result in a vertical line, which in turn would indicate a greater "work area" and a lower temperature at point (2). The significance of line (1, 4) is that this is the rate at which the entropy would change if free air were heated from the temperature at (1) to the temperature at (4) without increasing the pressure. This, in turn, indicates the amount of heat present in the exhaust when the area under line (1, 4) is calculated. Fuel burning at constant pressure (2, 3) causes a similar temperature-entropy change and represents the addition of heat to the gas. Finally, line (3, 4) shows the expansion of the gas through a turbine which is not perfectly efficient. If the turbine were 100 per cent efficient, the exhaust (point 4) would be at a lower temperature and the line (3, 4) would be straight down to its intersection with the lower curve.

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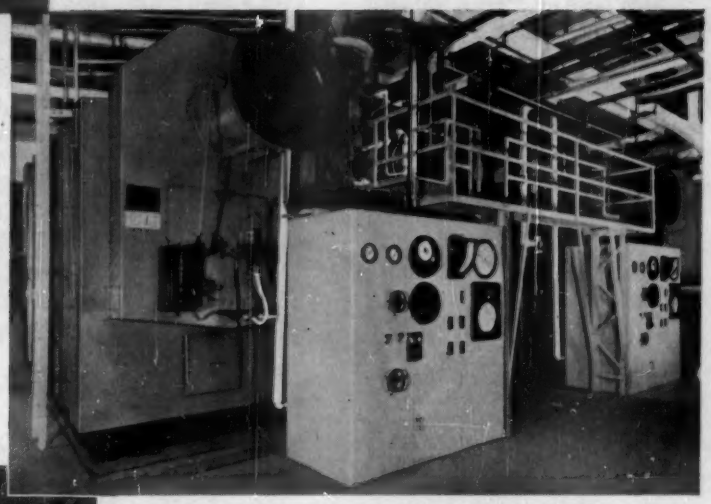

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Figure 36 shows a power cycle which is becoming very popular because it is efficient and not too complicated.

Intercooling and Regenerating

These two cycle variations show up strikingly on the P-V and T-S diagrams. The source of their extra efficiency is also apparent. Remember that the compressor work is that area to the left of the curve (1, 2, 3, 4) on the P-V diagram, then note the big bite taken out of the compressor work by intercooling between points (2) and (3). This means that the same pressure achieved by the compressor in the simple cycle can be achieved with much less work in the intercooled cycle. If the turbine produces the same amount of total power, therefore, the amount available at the turbine shaft is correspondingly greater.

Regeneration (using exhaust heat to heat the compressed air supply) shows up as the increase in volume between (4) and (5). This uses no additional fuel, as did a corresponding volume increase in the simple cycle. Fuel is burned only between (5) and (6) to give the pressure and volume found at (3) in the simple cycle. The products of combustion expand from (6) to (7) to produce more work.

But point (7) is above atmospheric pressure, though it seems to be the exhaust. The pressure drop across the regenerator accounts for this high exhaust pressure; i.e., the difference between pressures at points (7) and (8) are necessary to push the large flow of gas through the heat exchanger. To offset this loss in mechanical work left in the gas, we have the heat savings shown by area (7, 8, d, c). This was the heat used to increase the volume of the compressed gas from (4) to (5). Heat wasted in the exhaust gas, then, is limited to that shown by the area (1, 8, d, e).

Net turbine work of this cycle is shown by the odd-shaped area (1, 2, 3, 4, 5, 6, 7, 8, 1), and is larger than area (1, 2, 3, 4, 1) in the simple cycle.

It is in this cycle that the T-S diagram becomes most significant. Waste heat is shown by the area (8, 1, 2, 3, g, e, d, 8), and this includes the heat removed from the compressed air by the cooling water. Intercooling reduces the air temperature down to about the free air temperature (3) from which it is compressed back up to (4). The amount of heat

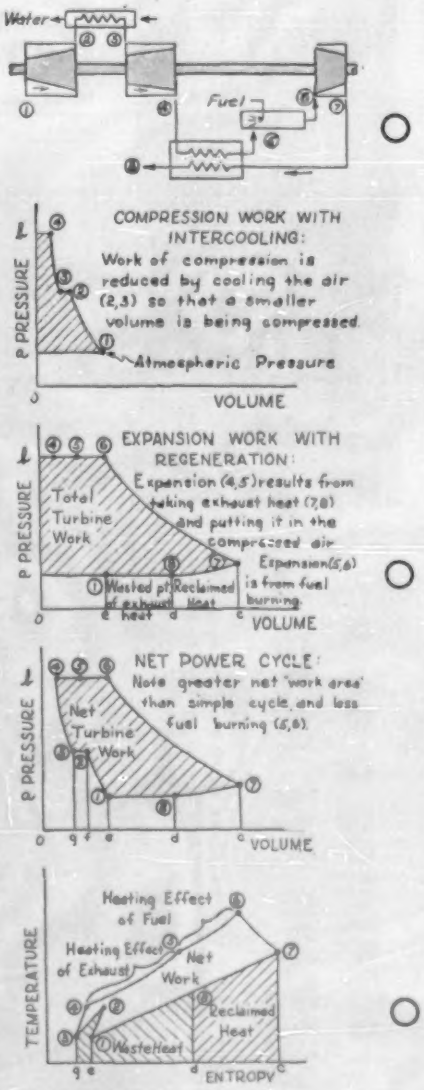
Water
Fuel
COMPRESSION WORK WITH INTERCOOLING:
Work of compression is reduced by cooling the air (2,3) so that a smaller volume is being compressed.
Atmospheric Pressure
P PRESSURE
VOLUME
EXPANSION WORK WITH REGENERATION:
Expansion (4,5) results from taking exhaust heat (7,8) and putting it in the compressed air.
Total Turbine Work
Wasted pt of exhaust heat
Reclaimed Heat
Expansion (5,6) is from fuel burning.
NET POWER CYCLE:
Note greater net 'work area' than simple cycle and less fuel burning (5,6).
Net Turbine Work
TEMPERATURE
Heating Effect of Fuel
Heating Effect of Exhaust
Net Work
Reclaimed Heat
Waste Heat
ENTROPY

Fig. 36

fold along this line—outside edges toward you

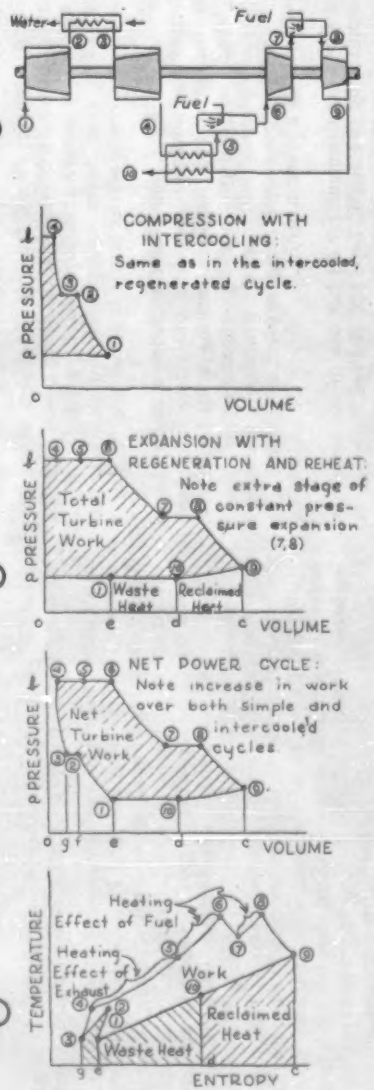

Fig. 37

added between (4) and (5) is limited by the temperature at point (7), since temperature (5) must be a little below (7). Similarly, the temperature at point (8) must be a little higher than at point (4) to effect any flow of heat from the exhaust to the compressed air. The T-S diagram, then, shows why it is not possible to recover all the exhaust heat for reintroduction into the cycle. That heat left below the temperature at (8) cannot be used within the cycle — but might be used in another cycle (perhaps a boiler).

Reheating Effect

Reheat, discussed earlier in this section, does about the same thing to the expansion curve that intercooling does to the compression curve — only in the opposite direction. Figure 37 shows this effect. Since reheat moves the curve to the right, and turbine work is the area to the left of that curve, it obviously increases the amount of work done.

From the air intake to the combustion chamber outlet, the equipment and P-V and T-S curves are identical in Figs. 36 and 37. Expansion from point (6), however, is stopped partway back down to atmospheric pressure and more fuel is burned in the gas. This increases the volume (7, 8) at constant pressure and still does not exceed the maximum safe temperature for the equipment (see 8 on the T-S diagram). When the expansion resumes in a second turbine (8, 9) it has nearly as much total energy as it had at (6). The exhaust (9) will also have a higher temperature than it had at corresponding points in the other cycles, and regeneration is doubly important. This higher temperature means that more of the heat added between (4) and (6) can come from the exhaust, however, and less fuel is required between (5) and (6). The net work areas on the P-V and T-S diagrams show a much greater area for less fuel consumption, so the cycle efficiency is considerably improved.

It is hoped that the discussion presented here has helped the various readers organize information already known, and that it has helped them understand some of the anomalies of the popular but little-used gas turbine. Gas turbines will undoubtedly become better established in stationary power plants in the years to come, and the developments will probably follow along the lines sketched out qualitatively by this primer.

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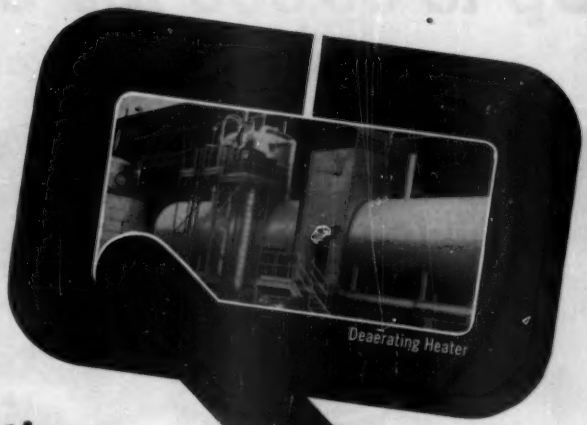
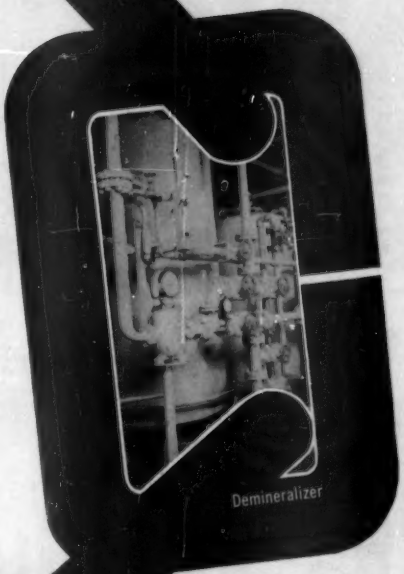
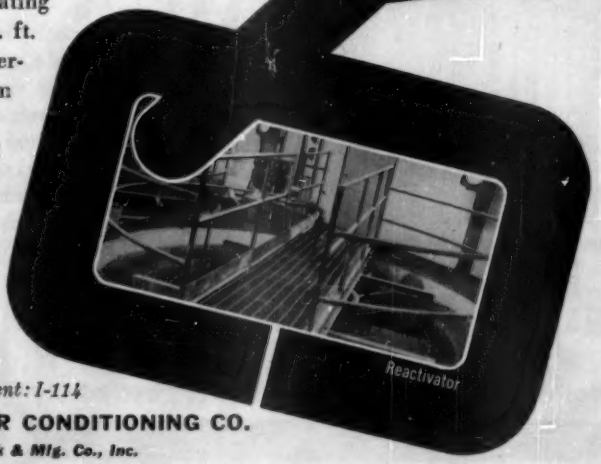
Albright Power Station







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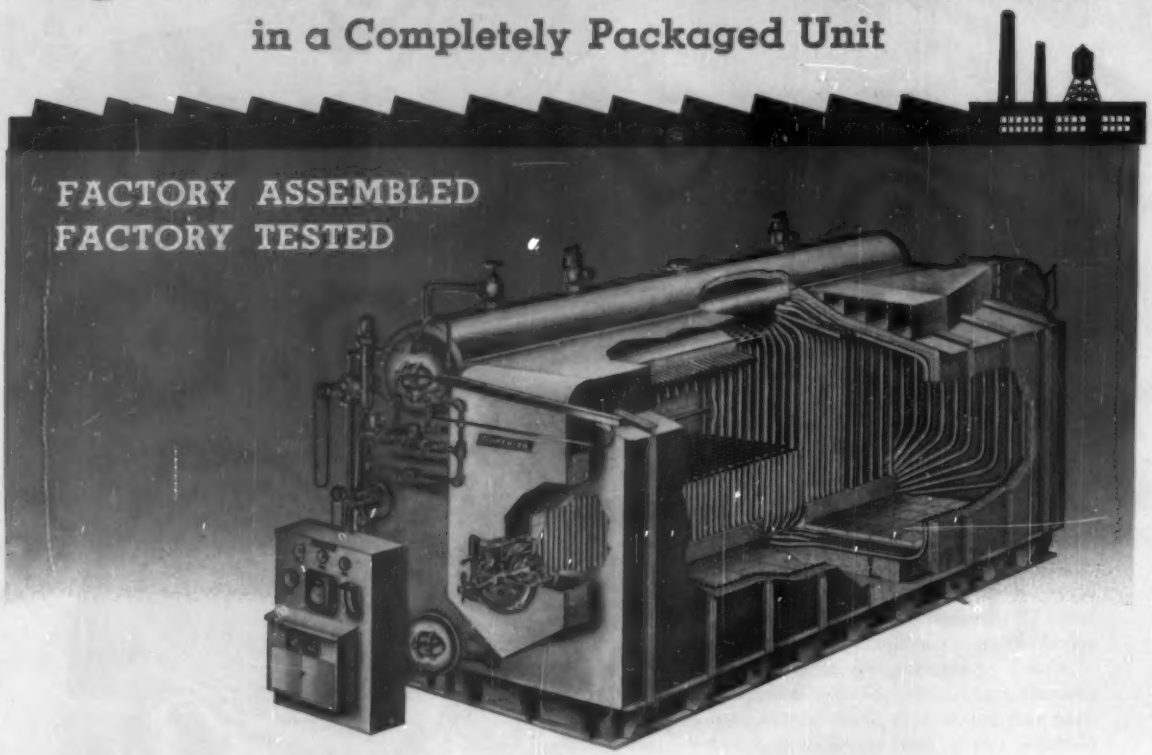

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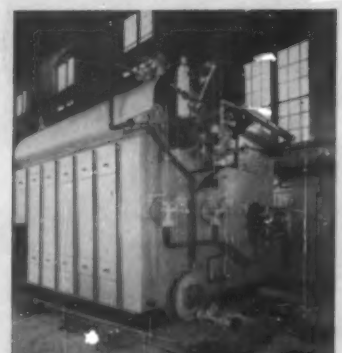

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201 **Check Valves** — Twenty-pp Catalog 30 presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 3000 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

202 **Lubricated Plug Valves** — Revised Catalog PV-2, 12 pp, presents steel and semi-steel valves designed to offer quick shut-off of erosive or corrosive fluids. Explains advantages of the lubricated tapered plug design of these valves and pictures single gland, screwed gland, and bolted gland types. Also shows accessories. The William Powell Co.

203 **Blow-Off Valves** — Bulletin B-426, 20 pp, on blow-off valves for boiler pressures up to 400 lb wsp, contains installation recommendations, construction information on Yarway seatless and double-tightening blow-off valves. Gives full ordering data. Yarnall-Waring Co.

204 **For Precise Control** — Fifty-pp Catalog 17 covers manufacturer's line of disc valves and accessories, providing full selection and ordering data, materials of construction, sizes. Describes manual and automatic controls for these valves which, it is noted, are available in any metal which can be cast or welded. Minimum pressure drop, quick closure, simplicity and other advantages are discussed. R. S. Valve Div., S. Morgan Smith Co.

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205 **Choosing the Right Valve** — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics are also discussed and the importance of stem operation is treated. Crane Co.

206 **Valve Chart** — Form 194, 24 pp, is a valve comparison chart, listing valve figure numbers of 15 major manufacturers and the OIC equivalent valve figure numbers. Compares variety of valves in ferrous and non-ferrous materials, describes different valve lines. The Ohio Injector Co.

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208 **General Service Valves** — Bulletin E-160, 16 pp, describes and illustrates design and construction of company's quick-operating valves, explaining their application to blow-off service and on chemical process, soot blowers, water column blow-down, and other types of pipe line. Everlasting Valve Co.

209 **Regulating Valves** — Bulletin 5305 describes double seated diaphragm regulating valves for use with control instruments, outlining special features of the valves, particularly the "flow line" contoured-body engineered for high capacity at low pressure drop. Leslie Co.

210 **Steam Trap Book** — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, trouble-shooting and repair. Armstrong Machine Works.

211 **Steam Trap Solutions** — Bulletin F. 151, 36 pp, is a newly revised edition of this company's well known booklet, "Solving Steam Trap Problems." Organized for easy reference, this illustrated booklet provides specifications and capacities of steam and float traps, air release valves, pipe line strainers. Tells how to calculate condensation loads and select traps for unit heaters, jacketed kettles, submerged surfaces. Gives tips on installing, servicing. The V. D. Anderson Co.

212 **Unions and Fittings** — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special features. Dart Union Co.

213 **Expansion Joints** — Rubber expansion joints for relieving strains and stresses in piping, absorbing vibration, and eliminating noise are the subject of 8-pp Form AD-137. General advantages of rubber expansion joints are presented, and spool-type, U-type and rectangular-type joints are described as to construction and intended services. Also provided is catalog sheet on all-Teflon joints and Teflon-lined rubber joints. The Garlock Packing Co.

214 **Asbestos-Cement Pipe** — Manufacturing methods in producing asbestos-cement pipe for water systems are described in this 8-pp bulletin, which points out savings in installation time and outlines characteristic advantages once the pipe is in the ground. Recommended procedures for installing pipe and assembling Ring-Tite coupling, as well as table of sizes and fittings are included. Johns-Manville.

215 **Stainless Steel Pipe Fittings** — Bulletin S-3-55 describes company's 150 lb stainless steel pipe fittings for corrosive, high and low temperature service, including 90 deg elbows, tees, 45 deg elbows, crosses, couplings, reducers, pipe caps, unions, plugs and bushings. Presents dimensional specifications in sizes ⅛ to 2 in. in both screw end and socket welding types. Applications in chemical plants,

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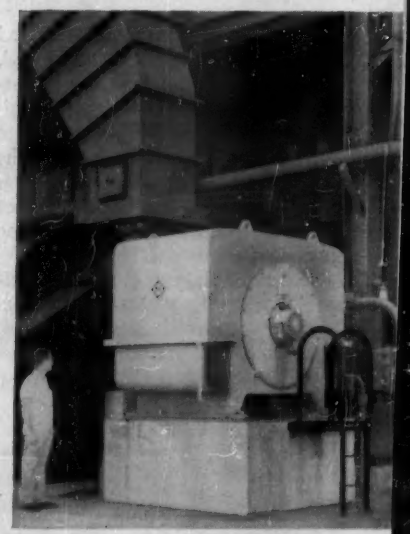

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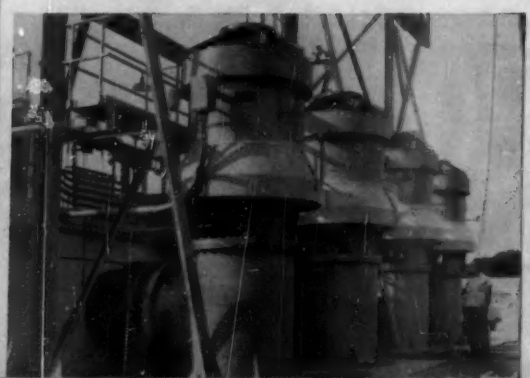

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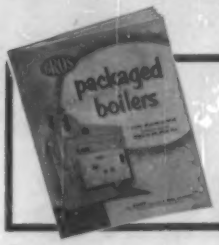

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refrigeration service, food and other process piping given. Watson-Stillman Fittings Div., H. K. Porter Co., Inc.

216 Seamless Welding Fittings — Alloy, carbon and stainless steel welding fittings are described in 6-pp Bulletin FB-500. Features are discussed briefly and grades and size ranges covered. Photos show fittings and flanges. Tubular Products Div., The Babcock & Wilcox Co.

217 Pipe Insulation — Mono-Kover, a lightweight one-piece pipe insulation, is described in this bulletin. Photos show how easily it is applied, and text covers its thermal resistance, permanence, resiliency, non-corrosive properties and lower applied cost. Also included are a thermal efficiency chart, insulation thickness selection table, and information on sizes and thicknesses available in this material. Baldwin-Hill Co.

WATER CONDITIONING

218 What's What on Ion Exchangers — Here are three booklets on ion exchangers: Nalcite HCR, a styrene type cation exchanger; Nalcite SAR, a strongly basic anion exchanger; and Super Nalcolite, a synthetic gel type zeolite for cation exchange. Tables and graphs explain performance of these water treating resins under various operating conditions. Physical characteristics, exchange capacities, regeneration techniques discussed. Bulletin 57, 20 pp, is on Nalcite SAR; Bulletin 58, 28 pp, Nalcite HCR; Bulletin 59, Super Nalcolite. National Aluminate Corp.

219 Handbook on Demineralizing — Comprehensive 40-pp Bulletin 5800-B compares various methods of water treatment, indicating the comparison between demineralizers and evaporators. It discusses the characteristics of the various types of available cation and anion exchange materials and offers data on operating costs of demineralizing. It tells when to use 2-bed, 3-bed, 4-bed, mixed or monobed demineralizers. It also indicates when decarbonators or vacuum deaerators should be installed. Cochrane Corp.

220 Feedwater Treating — Bulletin 1855, 30 pp features manufacturer's hot process Accelerator for treatment of boiler feedwater, illustrating and explaining its operation and advantages, also optional equipment. Contains excellent discussion of necessity for treatment of makeup water, selection of proper equipment. Also covers the limitations of hot process softening. Infilco Inc.

221 Steam System Treatment — This bulletin on Coravol for prevention of corrosion explains theory of corrosion, application of organic amines to steam systems (Coravol process) and presents case histories of use in different types of plants and industries. Coravol is part of a complete technical service providing chemical formulas for treatment of water, steam, brine, fuel. Western Chemical Co.

222 On Cooling Tower Wood — The protection of cooling tower wood is the subject of Technical Paper 130. Explains how chemical and bacteriological attack can be controlled by acid treatment and wood preservatives to kill fungi. W. H. & L. D. Betz.

223 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered

by company in providing formulations for individual plant requirements. Covers pretreatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

224 Demineralizers — Valuable information on demineralization is offered power engineers in comprehensive 24-pp Bulletin WC-111. Discusses demineralization in general and its advantages and applications. Basic types of demineralizers and their special uses are charted. Resins, piping, valves and accessory equipment are treated in detail. Book also provides flow charts showing demineralization systems for chemical plants and power plants. Graver Water Conditioning Co.

225 Corrosion Treatment — "Corrosion Protection of Steam and Condensate Return Systems" is a folder on amine treatment for boiler and condensate systems. This treatment is described as affording surface protection of the metal as well as raising pH value of condensate. The Bird-Archer Co.

226 For Industrial Water Softening — Greensand, zeolite and resinous exchange water softeners are described in 8-pp Form S-105. Discusses features and applications of each of these basic types and illustrates some installations. Includes capacity data and general specifications. Also describes and pictures controls for water softeners, pressure filters and deionizers. Illinois Water Treatment Co.

227 For Water Wells — An acidizing service for water wells, designed to increase water yield by enlarging formation channels and by removing scale deposits from pumps and screens is described in this folder. Lists advantages of this service, and cites some case histories. Dowell Inc.

ELECTRICAL EQUIPMENT

228 Motor-Generator Reference Book — Publication 51R7933 is a 50-pp booklet compiled to assist in the selection of motive power to handle most industrial applications. Neither textbook nor ordering catalog, this book provides a brief outline of the various types of motors, generators and motor-generator sets, telling their applications and operating requirements. Booklet is generously illustrated and includes performance data, ratings, information on methods of speed control. Allis-Chalmers Mfg. Co.

229 Motor Buying Guide — Bulletin GEC-1026, 28-pp, features company's standard a-c fractional and integral horsepower motors in most general use. Included are general- and definite-purpose fhp motors, and fhp gear motors. A section on selection of integral horsepower motors covers horsepower requirements, enclosures, starting current limitations, speeds, motor types, and selection of fuses and circuit breakers. Descriptions and specifications include single-phase, polyphase, totally enclosed fan cooled, and gear-type integral horsepower motors. Ratings, book prices, dimensions, frame numbers are included. General Electric Co.

230 Insulation Temperature-Resistance — Technical Publication 21T4, 16 pp, is an article on temperature-resistance characteristics of electrical insulation. Complete with tables and graphs, gives general information on variations in temperature characteristics, composite nature of electrical insulation, and practicability

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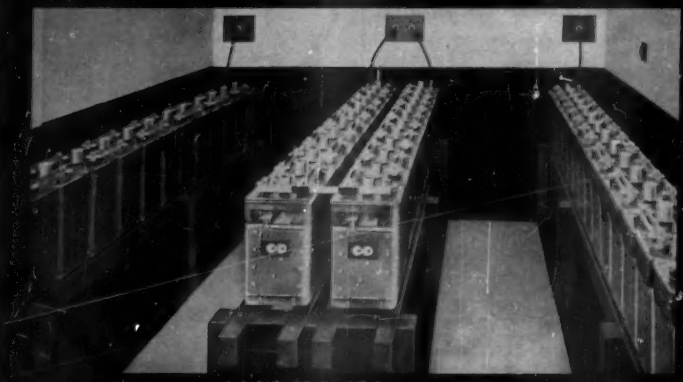

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of temperature compensation. Other chapters deal with determining insulation constants for temperature correction factors, and a practical method of obtaining insulation temperature. James G. Biddle Co.

231 The Answers on Wiring — "20 Questions and 20 Answers on Safety m.i. Wiring" describes and illustrates characteristics and advantages of this new wiring system. A complete table of types, sizes, weights and lengths, as well as a partial list of users included. General Cable Corp.

232 High-Power Batteries — Bulletin CP-538/55 covers company's line of Hi-Power batteries for use in the control, switchgear, emergency lighting and auxiliary power fields. Includes data on battery ratings and capacities, details of design and construction, dimensions, weights and types of containers. C & D Batteries, Inc.

233 High-Capacity Fuses — Form HCS, 6 pp, describes fuses of unlimited interrupting capacity on voltages to 600, designed to afford protection for loads of 600 to 5000 amp. Includes test data, charts on opening time, current limiting effect. Bussmann Mfg. Co.

PUMPS, COMPRESSORS

234 Boiler Feed Pump — A barrel-type boiler feed pump for high pressure, high temperature service and designed to go on the line quickly without preliminary warm-up is the subject of 12-pp Bulletin 1525. De Laval Steam Turbine Co.

235 On Vertical Pumps — Sixteen-pp Bulletin describes and illustrates application of vertical industrial service pumps for liquid transfer from short settings in both industrial and process services. Points out advantages and describes three basic designs. Stresses versatility of the pumps due to design flexibility. Also gives general recommendations for obtaining optimum performance, and includes photos of typical installations. Peerless Pump Div., Food Machinery and Chemical Corp.

236 Controlled Volume Pumps — Bulletin 953, 24-pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water treating systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, and systems for waste and sanitary water treatment included. Milton Roy Co.

237 Balanced Opposed Compressors — Engineering data on company's balanced opposed compressors, 3000 to 10,000 hp (top range in tandem arrangement) is contained in 36-pp Bulletin L-679-B1. Presents information on operation, drives, design features, running gear, lubrication, valve action, capacity control, coolers and accessories. A chart listing approximate dimensions is included, along with photos of compressor installations. Worthington Corp.

INSTRUMENTS AND CONTROLS

238 Metering and Control Equipment — Sixteen-pp Bulletin 18 is a comprehensive catalog offering information on company's meters, control equipment and engineering services. It is written for

engineers in power plants, public utilities and process plants. Fifteen measured variables common to power and process operations form the index for selecting appropriate equipment. Bailey Meter Co.

239 Boiler Feed Control — Bulletin 1003, a 12-pp catalog on boiler feed regulators, is illustrated with large application photos and detailed schematic drawings and charts. Relay and direct operation are covered. Case studies of representative boiler loads are presented to show stability of the Flowmatics in controlling feedwater automatically. Copes-Vulcan Div., Continental Foundry & Machine Co.

240 Electronic Flow Meters — Publication 55-1074-222, 12-pp, describes company's line of electronic flow meters for measurement of differential pressures, liquid level, fluid, gas, air or steam flow, temperatures and pressures. Points out advantages, describes mercury-less transmitters, transmission system, receiver, integrator, other features. The Hays Corp.

241 Indicating Flow Meter — Bulletin 18-A, 22-pp, discusses advantages, construction and operation of company's Type H indicating flow meter. Presents technical data on the principles and theory of fluid measurement and discusses orifice type meters and orifice meter principles. Offers examples of flow rate calculations. Schematic drawings and diagrams, tabulated technical data and specifications are included. The Meriam Instrument Co.

242 Sampling System — A newly developed system for continuous sampling and oxygen measurement of combustion processes is described in Bulletin 703. Points out advantages of system and diagrams component parts. Selection of sampling tube and gas selector units is discussed. Arnold O. Beckman, Inc.

243 Easy Reading Gage — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, explains operation. The Reliance Gauge Column Co.

244 D-C Amplifier — Twelve-pp Bulletin MSP 111.1 provides pictorial diagrams and descriptive information on company's PowrAmp Model P, an electronic low-voltage linear amplifier designed to increase the speed and accuracy of low level d-c voltage measurements. Discusses performance and construction features of the amplifier, and describes some applications. Specifications and ordering suggestions given. Hagan Corp.

COAL, ASH HANDLING

245 Burning Bituminous Coal — This 24-pp illustrated booklet is a compilation of numerous actual case histories of industrial plants and institutions which burn bituminous coal "the modern way." Stressing operating economy achieved, these case histories show problems overcome, equipment used, and savings realized. Bituminous Coal Institute.

246 Fly Ash Collection — The successful and economical separation of fly ash from boiler flue gases is discussed in 28-pp Catalog G405. Explains need for collection equipment and gives physical characteristics of fly ash. Describes company's Multiclone equipment as to principle of operation, performance and advantages. Western Precipitation Corp.

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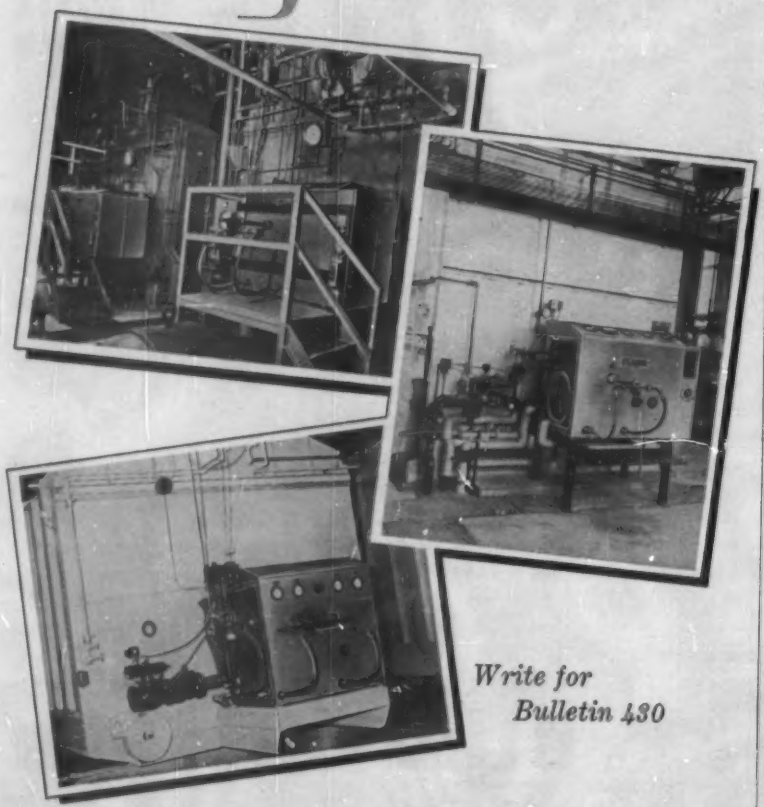

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247 Spreader Stoker — Sixteen-pp Bulletin 800 describes manufacturer's Type C-C RotoStoker, a relatively small spreader stoker offering continuous cleaning and ash discharge advantages of larger units, without need of a basement for ash-removal. Explains this and other operational advantages of the stoker, which is adapted to modern steam boilers with output capacities of about 5000 to 75,000 lbs of steam per hour. Detroit Stoker Co.

248 Coal Crusher — Company's WC and WS series rolling ring coal crushers are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulverizer Co.

BOILERS, GENERATORS

249 Packaged Boilers — This 16-pp illustrated catalog describes manufacturer's new Type VP package boiler. Following a section of background information is an outline of the principal design features of these boilers, which are shop assembled and provide steam capacities from 4000 to 30,000 lb per hour. Space requirements are shown in a table along with typical specifications. Also described is control system. Combustion Engineering, Inc.

250 Standard Boilers — Eight-pp Bulletin WT-8 describes company's "S" series of boilers with capacities ranging from 10,800 to 50,000 lb. Lists data and specifications on each of the models and sizes, and discusses general design features and special "S" type construction features. Wm. Bros. Boiler & Mfg. Co.

251 Automatic Boilers — This bulletin describes 17 sizes of Powermaster packaged automatic boilers from 15 through 500 hp for steam process, steam and hot water heating service. Lists such advantages as three-pass design, forced draft and automatic controls. Describes firing equipment for light and heavy oils, gas; shows various fuel firing arrangements. Orr & Sembower, Inc.

Postage-free cards for ordering catalogs are on page 118. You may also use the cards to order literature mentioned in the ads.

252 Steam Generators — Illustrated Bulletin SB43, 20 pp, describes company's VL factory assembled generators combining 2-drum water-tube boiler, integral water cooled furnace, brick work, insulation and steel casing. A large cutaway illustration shows design details, and gas travel. Erie City Iron Works.

253 Compact Generator — This bulletin describes a packaged water tube generator, company's Type DK, available in units for 8400 to 45,000 lb of steam per hour. Gives features, size and capacity data on these boilers which are designed to require less space than many water tube units. E. Keeler Co.

254 Steam Generator — This manufacturer's new Type D steam generator, a packaged unit for pressure firing with gas, oils or combination of fuels, is de-

scribed in an 8-pp catalog. Gives complete data and dimensions on this water tube generator which is available in 17 sizes with capacities from 8000 to 40,000 lb of steam per hour. Fully illustrated, booklet explains economical steam production. Superior Combustion Industries, Inc.

REFRACTORIES

255 Refractory Concrete — Basic information on recommended practice for mixing and placing refractory concrete, used in the metal, power, ceramic, and petroleum refining industry as a material to withstand service temp to 2600 F or more, is presented in this 16-pp manual. Sections are devoted to special properties of refractory concrete, aggregates, refractory insulating concrete, and structural design. Charts and tables afford easy reference. Universal Atlas Cement Co.

256 Refractory Notes — Included in Vol. XV of this company's Thermogram is an illustrated article on a method for decreasing hot topping costs in steel mills with minimum capital expenditure. Another story tells how bonded brick assemblies cut installation time in a coke plant. Refractory & Insulation Corp.

TUBING AND ACCESSORIES

257 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads. Roto Div., Elliott Co.

258 Nickel Pipe and Tubes — Bulletin T-17 is a 28-pp technical bulletin on the fabrication and design of nickel and high nickel alloy pipe and tubing, illustrated throughout by drawings and photos. Presents tables on mechanical and physical properties, ASME code requirements, recommended welding procedures. The International Nickel Co., Inc.

259 Life Extension for Condenser Tubes — The 32-pp current edition of this booklet reports on research into the causes of corrosion and means of combating them, as well as the choice of condenser tube materials. Points out that Admiralty metal, long a standard for power plant condenser tubes, works satisfactorily in most installations, but other alloys may be necessary in some circumstances. Revere Copper and Brass, Inc.

260 Tube Cleaners — Catalog 76-A provides 48 pp of information on manufacturer's line of tube cleaners. Following equipment selection and operating hints, this practical catalog describes and pictures cutter heads and drill heads, brushes, and motors, giving sizes, application information. Air valves, hose, lubricators are described. Thomas C. Wilson, Inc.

BURNERS

261 Automatic Burner — Bulletin 420 contains approximately 30 pp of engineering data on a new burner unit for gas, oil or combination firing and sized for capacities to 42,000 lb of steam per hour. Separate sections of this looseleaf manual are devoted to photos and discussion of special features of the burner, general specifications, parts list, wiring and piping diagrams, explanation of operating sequence, and performance data. Available to qualified power engineers, please state your job title when requesting this bulletin. Peabody Engineering Corp.

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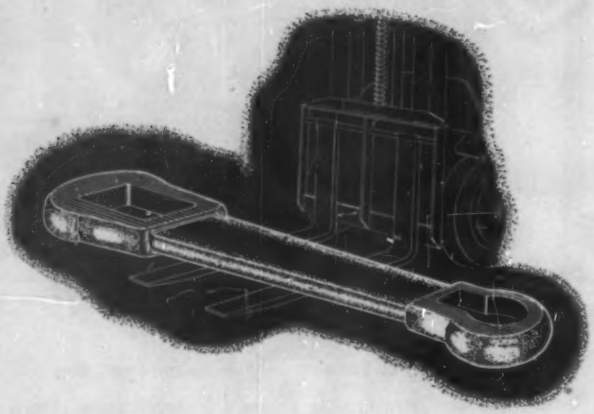

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262 Oil and Gas Burners — Bulletin OB-53, 28 pp, gives principles of selection and application of oil or gas burners, or a combination of both for standard and wide capacity range operation, together with air registers and fuel oil heating and pumping sets. Conversion table shows approximate relationships between quantity of oil burned, boiler capacity and air required for combustion. The Engineer Co.

263 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces, where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

OTHER EQUIPMENT

264 Steam Accumulator — How the steam supply and demand can be balanced by means of company's steam accumulator is told in Bulletin RA-52-8. Stresses reduced boiler capacity required and increased boiler efficiency afforded by use of the accumulator, other advantages. Discusses operating principle, tells how to figure capacity. Foster Wheeler Corp.

265 Fluid Drives — Bulletins 9419 and 9519 are an illustrated catalog and selection guide on company's new Type VS Class 2 Gyrol fluid drives. Catalog discusses advantages and applications of the drives, covering speed control, power savings, simplified installation etc. A sectional view shows construction and principle of operation. Dimensions for six sizes of drives are provided. Selection guide consists of tables indicating proper drive to use with motors from 7.5 to 800 hp. Separate tables cover variable and constant torque loads. American Blower Corp.

266 Corrosion, Abrasion Control — Modern practices and products for the positive protection of metal equipment from the effects of corrosion and abrasion are described in this 16-pp bulletin. Covers factory and field application of rubber or synthetic linings to metal parts or products, and maintenance coatings available for application by plant personnel. Also gives detailed information on accelerators, thinners, primers. Goodall Rubber Co.

267 Data on Insulations — Insulation solutions for a wide range of temperature problems are charted in this folder. Provides brief descriptive information and tells forms available for high temperature applications, for intermediate temperature use, for hot and cold water and low pressure steam, for ice water and frigid temperatures. Mundet Cork Corp.

268 Tubing Support System — Twelve-pp Bulletin 254 presents a system for permanent and continuous support of instrument tubing. All items and fittings are illustrated by photo or dimensional drawing. Details of actual installations show some of the methods by which this system can be quickly and economically erected at the job site. Instrof Inc.

270 Refrigerator Condensers — Bulletin RC-2, 38 pp, utilizes drawings, tables and engineering data to show how to select proper type from company's line of ammonia and Freon condensers for refrigeration services. Illustrates horizontal multipass shell and tube types; vertical singlepass shell and tube types. Gives pipe

sizes for ammonia and Freon lines. Henry Vogt Machine Co.

272 Bearing Lubrication — Vol. XL, No. 10 of this company's Lubrication magazine provides an excellent 12-pp article on industrial bearing lubrication. Illustrated with photos and drawings, text covers such subjects as bearing design; bearing surfaces; bearing overhaul; aspects of lubrication, including factors involved in choice of turbine oils and diesel lubricants, and the deleterious effects of moisture; and the life expectancy of bearing lubricants. The Texas Co.

274 Dust Collection — Aerodyne dust collectors in chemical processing and other industries are discussed in 8-pp Bulletin 171. Explains theory and design of collector system, includes drawings of the various types covered. The Green Fuel Economizer Co., Inc.

275 Preheating Combustion Air — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also covered. Air Preheater Corp.

277 Heat Transfer Apparatus — Condensed Bulletin HT-1 highlights representative products in company's line of heat transfer equipment. Includes oil heaters and coolers, strainers, evaporators, heat exchangers, radiafin air coolers, tubes, pipes, and coils. Cross-section views of typical units are shown, brief descriptions given, and references to other bulletins are listed. Schutte and Koerting Co.

278 Selecting a Blowdown System — A simplified chart for calculating savings possible through heat recovery with a properly sized automatic continuous blowdown system is offered in this pamphlet. Chart is based on total dissolved solids in the boiler water and the permissible concentrations. Henszey Co.

279 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Co.

280 Turbine Speed Control — Thirty-pp wire-bound Bulletin H-21 is titled, "Fundamentals of Turbine Speed Control." It is an elaborately illustrated, educational booklet intended to clarify the operation of common types of automatic speed control for steam turbines. An introductory section covers general fundamentals of automatic control systems, and includes a key to control terminology. Simplified diagrams show operating principles of actual control systems. Elliott Co.

281 Steam Condensers — Some recent additions to this company's power plant condenser installations are pictured and described briefly in this 24-pp booklet. Also included are an engineering section on condenser design factors, and sections devoted to air removal equipment, to steam condenser specialties, and to maintenance services available. Condenser Service & Engineering Co., Inc.

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FIG. 29
Cylinder with Impeller

FIG. 17-28
Cylinder

FIG. 215
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FIG. E-57
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FIG. 212
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FIG. E-811
Flapper

FIG. E-1810
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POWER ENGINEERING
Yearly Index

Index of POWER ENGINEERING'S 1955 articles will be included in the January 1956 issue instead of the December 1955 issue, as we have done in December issues for years.

This slight change, necessitated by certain mechanical make-up problems, will enable us to improve the index to serve you better.

Watch for it in January and let us know what you think of the change.

OBITUARIES

Blaine S. Smith

BLAINE S. SMITH, retired president of Universal Atlas Cement Company and prominent figure in the cement and allied industries, died October 27 at New Rochelle, N. Y., Hospital.

Associated for more than 37 years with the cement company, a U. S. Steel Corporation subsidiary, Mr. Smith retired on December 31, 1953, continuing for a time with the company in a consulting capacity. He began his career in the cement industry in 1908 as salesman for the Universal Portland Cement Company in Chicago. There, he progressed through various positions and from 1915 to 1928 served the company as general sales manager, director and vice president. From 1928 to 1936, he was president and director of the Penn-Dixie Cement Corporation in New York, returning to Universal Atlas as president and director in 1936, in which capacities he served until his retirement.

H. L. MacElroy

NOTICE is given of the death of H. L. MacElroy, general sales manager of Springfield Boiler Co., Springfield, Ill., who was stricken suddenly on October 17, 1955, and succumbed almost immediately thereafter. Mr. MacElroy had had more than 25 years of experience in the steam generating and fuel burning fields and was well known in engineering circles throughout the country, having previously served with Combustion Engineering Inc., in Chicago, New York, and Boston. During World War II, he was general sales manager of

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Combustion's Marine Boiler Division. Mr. MacElroy joined the Springfield Boiler Co. five years ago as head of its Chicago sales office and later was appointed as general sales manager for the company.

NEW ENGINEERING BOOKS

America's Needs and Resources, a new survey; by J. Frederic Dewhurst and Associates; 1148 pages, size 7½ by 10¼ in., cloth cover. Published by The Twentieth Century Fund, 330 West 42nd Street, New York 36, New York. Price $10.00.

Dr. Dewhurst, Executive Director of the Fund, and a staff of 25 specialists worked five years to complete this book. It is a complete revision and enlargement of a study that originally appeared in 1947. Its purposes are two: To evaluate the present position of American economic resources production and consumption, and it establishes a basis of comparison with earlier figures to simplify and clarify projections under the future.

While this book may seem somewhat like the statistical abstract of the United States, it goes further than this. It not only reports statistics regarding all phases of social industrial and economic statistics, but it also evaluates and comments on the significance of these trends. Its projections under the future are conservative, but one is impressed by the rosy picture painted of productivity, purchasing power, and standard of living forecast for the future. Evaluations of the future use of machines, capital investment in industry, and the time tables for future growth should be very important to the forecasting of required production of goods and services.

We can recommend the book as a basis for specific market studies, including the power industry studies, and as an authoritative source of trends keyed to specific historical figures.

★ ★ ★

Thermodynamic Properties of Methane-Nitrogen Mixtures, IGT Research Bulletin No. 21; 52 pages; size 8½ by 11 in., paper cover. Published by Institute of Gas Technology, 17 West 34th Street, Technology Center, Chicago 16, Illinois. Price $3.50.

This bulletin presents data required for computing the energy requirements of processes to separate nitrogen from natural gas by liquefaction and distillation. The bulletin goes a step further in presenting means of employing this data, and examples are quoted for selected separation cycles. Comparative energy requirements, based on attainable compressor and expansion turbine efficiencies, for five cycles with varied operating conditions are tabulated.

Included among the numerous illustrations are Mollier charts for nitrogen and methane, and a temperature-entropy chart

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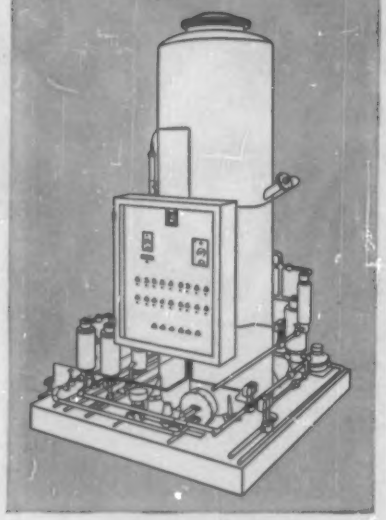

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Engineering Books

continued from page 129

for methane. Each of these charts has also been issued full-scale (22 by 24 in.) and can be purchased separately from the Institute of Gas Technology.

This is highly specialized information, of interest only to those engaged in the design of nitrogen-methane separation systems, but it would be a valuable addition to any data file dealing with the properties of gases encountered in industry.

★ ★ ★

Connecting and Testing Direct-Current Machines by F. A. Annett and A. C. Roe. Third Edition, 328 pages, 218 illustrations. Size 6¼ by 9¼ in., cloth. Published by McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N. Y. Price $5.00.

This book consists of two distinct parts: one dealing with reconnecting direct-current machines for a change in voltage or speed or both; and two, rotating and remedying faults in direct-current machines. The two sections have been so arranged that one may be used independently of the other. Since the second edition of this book was published, many improvements have been made in insulation and testing methods. Silicones, glass fibre, enamels and other materials permit safe operation of electrical equipment and temperatures not dreamed of 20 years ago. In addition, new methods of testing armature windings and field coils and detecting insulation defects before they cause failures are now available. These and other improvements have made necessary a third edition of this book to bring it up to date to cover new developments and practices.

The material is designed to give electrical engineers and maintenance and repair workers practical help in rebuilding d-c machines for higher ratings and longer operating life and for testing winding faults under a wide variety of conditions. There are data on changing a series type into a shunt machine or vice versa, on converting a d-c generator into a motor or vice versa, figuring new wind-

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Also contained in this third edition is new material on locating faults in field coils, high temperature insulations, insulation testing devices and the use of high frequency high voltage testing equipment.

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ASTM Standards on Coal and Coke (With Related Information), prepared by Committee D-5 on Coal and Coke of the American Society for Testing Materials. Size 6 by 9 in., 164 pages, paper cover. Copies available from ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa. Price $2.25; to members of the Society, $1.70.

This 1954 edition of ASTM Standards on Coal and Coke includes 27 methods of test, definitions, and specifications for coal and coke, and the standard specification for the classification of coal according to rank and grade. It is of particular use to electric utilities companies with coal-fired steam generating plants, coke and gas manufacturers, governmental agencies, and others which buy coal and coke in large quantities on specification.

In addition to the standards, eight appendices give proposed methods of test which are published in draft form for the purpose of soliciting comments.

ASTM Manual on Industrial Water, Second Printing, September, 1954. Size 6 by 9 in., cloth binding, 430 pages including index. Published by American Society for Testing Materials, 1916 Race st., Philadelphia, Pa. Price $5.00.

This ASTM Manual, now in its second printing, offers a broad discussion on the nature and uses of industrial water, plus up-to-date test methods and specifications developed by leading authorities in the field. Although the first eight chapters are essentially identical to the first printing, 11 new test methods, 8 revisions of existing methods, a complete table of contents, and a detailed index have been incorporated into this second printing.

New material includes 10 methods for: chemical oxygen demand (dichromate oxygen demands) of industrial waste water; chlorine requirement of industrial water and industrial waste water; in industrial water (residual chlorine, nitrate-ion, sulfite ion); in industrial waste water (odor, oil matter, pH, sulfides); also determination of thickness of internal deposits on tubular heat exchange surfaces; and one scheme for analysis of industrial water and industrial waste water.

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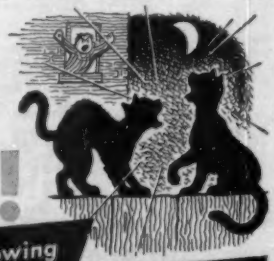

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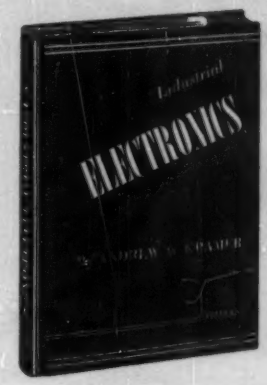

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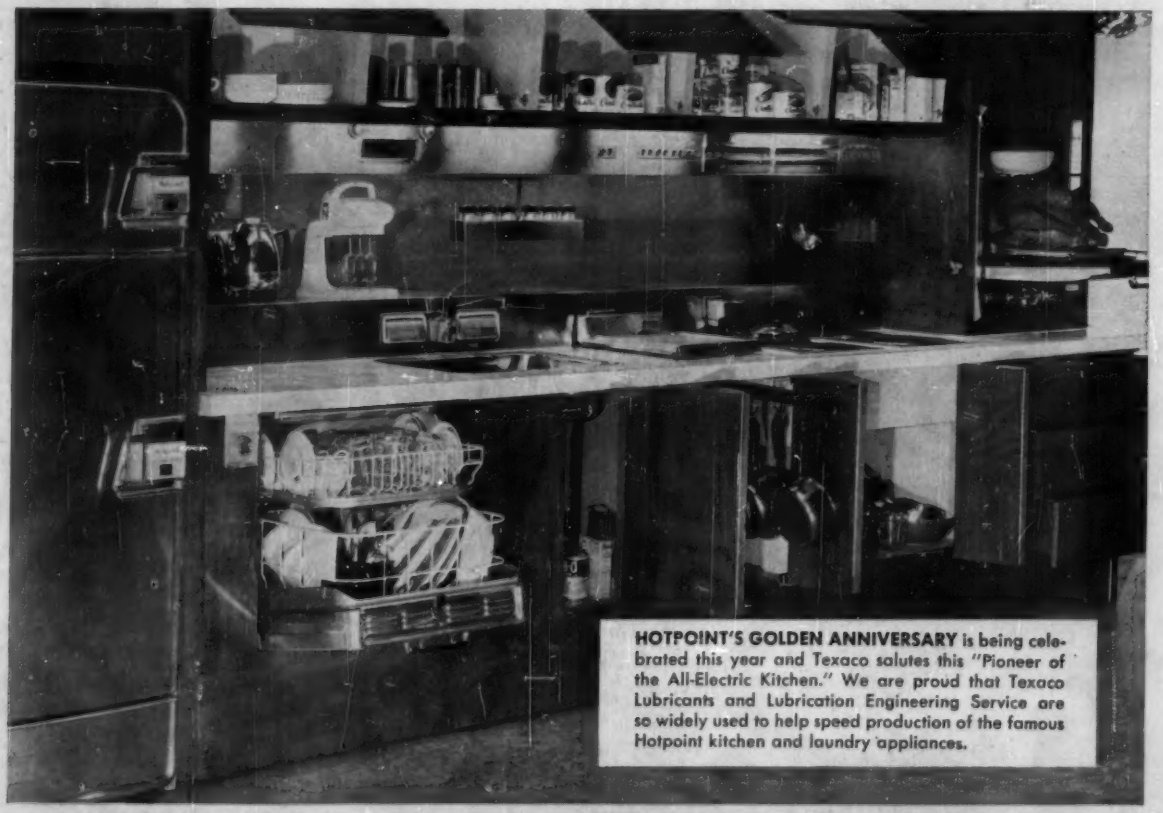

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